THE

ELECTRICAL REVIEW.

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CONTENTS:

	PAGE
The Phenomena of Flame	441
The Best Frequency for Alternating Current Installations (*illus.*)	443
Cost Price of Electrical Energy in Central Stations	445
An Easily Remembered Rule (*illustrated*)	447
Electric Discharge through Gases (*illustrated*)	447
Electrical Communication with Lightships (*illustrated*) ...	448
Photometry	448
Review:—Traité de Télégraphie Electrique	449
Electricity at Messrs. Dobson & Barlow's Machine Shops ...	449
Electrical Communication with Lighthouses and Light-vessels	450
Arc Lighting (*illustrated*)	452
Wind Motors (*illustrated*)	454
Correspondence:—The Heilmann Locomotive	455
Manganine	455
The Permanent Sample Exhibition for South Africa ...	455
The Pacific Cable Scheme	455
Legal:—W. Shelfer and Meux's Brewery Company *v.* City of London Electric Lighting Company	456
Ebbsmith *v.* Dawson and Others	457
Business Notices, &c.	457
Contracts Open and Closed	458
Notes	459
City Notes, &c.	463
Traffic Receipts	464
Share List of Electrical Companies	465
Proceedings of Societies:—	
The Institution of Electrical Engineers (*illustrated*) ...	466
Northern Society of Electrical Engineers (*illustrated*) ...	468
New Patents	471
Abstracts of Published Specifications	472

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THE PHENOMENA OF FLAME.

THE *Annalen der Physik und Chemie* (Band 51, Heft 3) contains an article by E. Pringsheim, in which he reviews Paschen's treatment of the theory of the illuminating qualities of heated gases, and raises many points of interest. In his work "Ueber die Emission erhitzer Gase," Paschen believed himself to have settled the question put forward by Hittorf and W. Siemens, and with which Pringsheim had also been occupied, namely, that O, N, CO_2, and water-vapour, under high temperatures, far exceeding those of the non-luminous Bunsen flame, do not send out visible rays. The contention has hitherto been that the light emitted from flames is not a consequence of the high temperature, but is brought about immediately by chemical action; upon this follows the wider question as to whether gases have, in any degree, the property of emitting light rays by the mere raising of temperature. That the above-mentioned gases do send out heat rays in consequence of their temperature was taken for granted by Siemens; but Pringsheim thinks that this opinion was based upon a disputable experiment, his own observations having gone to show that the light emitted from metallic vapours at high temperatures exhibits phenomena which are to be referred to the co-operation of chemical and electrical actions. The light emitted from Na and Li vapours, without electrical discharge, is not a consequence of the temperature, but is brought about exclusively by the chemical process, and not a single case is known in which a gas emits light solely through increase of temperature without the co-operation of chemical or electrical action. On the other hand, electrical and chemical action alone, without the heightened temperature, can produce luminosity in gases, and, for this reason, Pringsheim holds that the hypothesis of gases emitting light merely on account of temperature is an assumption, tenable neither theoretically, nor as the result of experiment. He defines a luminous gas to be one from which a lineal spectrum of the gaseous elements can be obtained, these being the subject of his observations. With regard to spectral bands he offers no opinion, but merely points out that those spectral bands which can be resolved into lines have a character so completely different from the lineal spectra of the elements that it would be inconceivable in itself to admit for the origin of spectral bands an hypothesis which has to be excluded in the case of spectral lines. It is quite inadmissible to transfer the opinions obtained for lineal spectra of the elements to any discontinuous spectrum; this is an error into which Paschen is claimed to have fallen when writing upon the matter, where he says that "Hr. Pringsheim seems to understand only the commonly observed metallic lines, for instance, the D line, of Na, his theory being unintelligible if we understand it to refer to anything else than a discontinuous spectrum." Pringsheim objects to this extrapolation, and defends himself by showing that "discontinuous" spectra

occur also in solid and liquid bodies and that, in these experiments, he is only concerned with the characteristic lineal spectra of gases. Before, however, going into the question as to which class of spectra the emission from CO_2 and water-vapour belongs, the writer investigates what new proofs can be adduced for the fact that the ultra-red light emitted by these gases is discontinuous, and a mere function of temperature. The experiments of Tyndall, Magnus, and Röntgen, have shown that CO_2 and water-vapour absorb heat rays and emit them in a heated condition. H. W. Julius has proved that these gases, when in the flame, produce characteristic emission spectra in ultra-red; and Angström has found that CO_2 possesses an absorption spectrum with a maximum between $\lambda = 3{\cdot}5$, and $\lambda = 5{\cdot}4\ \mu$ (which agrees with the emission maximum found by Julius); and a weaker one between $\lambda = 2{\cdot}3$ and $\lambda = 2{\cdot}8\ \mu$. It having therefore been proved that these gases have a characteristic absorption spectrum, that they emit, when produced in a flame, an emission spectrum corresponding to the same, and that they emit heat rays when heated in contact with hot metals, there can be no doubt that the spectra of these hot rays correspond to the absorption spectrum of the two gases and their emission spectra in the flames. Experimenting with gases in contact with hot metals, Paschen finds, by a radiation method, that CO_2, which at a temperature of 842° C. produces in the emission maximum a deflection of 566 scale divisions on his galvanometer, with sinking temperature diminishes so that at 114° C. there is a reading of only three scale divisions; and he concludes that dissociation cannot be the cause of this emission, and hence that it is not possible to accept a dissociation theory in the general sense for CO_2 in contact with platinum at 120° C. Pringsheim does not agree to this; he shows that the former method for proving the dissociation by vapour density was sufficiently sensitive to detect the phenomenon to a small extent at 1,700° C., and he therefore argues that there is no reason why the three divisions obtained with the more sensitive radiation method at 114° C. should not be attributed to dissociation. It is known that dissociation in the initial stage proceeds but very slowly with the temperature, and therefore, from the standpoint of the dissociation hypothesis, the results of Paschen might have been predicted.

According to the measurements of Paschen, the emission spectrum of CO_2 consists chiefly of a band which goes nearly from $\lambda = 4{\cdot}0$ to $\lambda = 5{\cdot}5\ \mu$. Water-vapour has several maxima, and the emission reaches uninterruptedly from $\lambda = 0{\cdot}8$ to far beyond $\lambda = 8\ \mu$. Secondly, the emission of CO_2 covers a spectral area which, in the normal spectrum, is about three times as large as the whole visible spectrum; whilst that of water-vapour covers the whole area investigated, which is about 20 times as large as the visible one. Here it can scarcely be said that the spectrum is discontinuous, since there is no body so completely black as to absorb and emit all rays from $\lambda = 0$ to $\lambda = \infty$. All solid and liquid bodies when examined in sufficiently thin layers exhibit analogous absorption spectra to those of CO_2 and water-vapour.

Paschen, as the result of quantitative tests, finds the intensity of the CO_2 maximum to be about 1,200°, which is almost comparable with that of the Bunsen flame, and he concludes that the emission is merely a consequence of temperature of the flame. This, however, cannot very well be brought into harmony with the experiments of Julius. In the Bunsen flame methan is present in considerable quantities, which, according to Tyndall, absorbs about 4·5 times as strongly as CO_2, and which, according to Angström, possesses a characteristic maximum. Further, the results of Paschen are said to disagree with those of Von Helmholtz, who found that through previously heating the gases to be burned the total radiation of the flames is, frequently, very considerably decreased, although the temperature of the flame may be actually higher than when using gas at ordinary temperature.

Ayrton's Law for the Resistance of Telegraph Instruments.

The recent paper on "The Best Resistance for the Receiving Instrument on a Leaky Telegraph Line," read before the Institution of Electrical Engineers by Prof. Ayrton, was, in many respects a suggestive one, though its practical value may be doubted; for this country, at least, it may safely be said that it has no bearing. There is, however, a feature in papers of the kind which appears to be invariably overlooked, and it is one which never seems to be appreciated. The mathematical analysis, so far as it goes, calls for little criticism, but it is an analysis which stops at the threshold of the question, and those who deal with such subjects never carry their investigations far enough. The whole argument of the paper referred to deals with a consideration of what is the *best* resistance to give to the instrument, and there are many who would be inclined to believe that any departure from this exact value would seriously affect the efficiency of the apparatus, whereas if the mathematical investigation were properly expanded it would be shown that a very considerable departure from the precise value could take place without any material effect being produced upon the efficiency of the apparatus. As an example of this we may refer to the well-known law that a galvanometer in order to have its maximum sensitiveness should have a resistance equal to that of the external circuit. Now it has been shown* that this maximum law may be very largely departed from without greatly affecting the sensitiveness of the instrument; in fact, that if the resistance is made either *nine* times or *one-ninth* the value for maximum sensitiveness, yet the sensitiveness would only be reduced by about one-third, *i.e.*, to two-thirds of the maximum value. In the case considered by Prof. Ayrton a similar condition holds good, and it is a great omission that it was not pointed out.

The Dissociation Theory.

The molecular rotation of salts in dilute solution is independent of the character of the inactive ion of the salt. This statement is due to Ondemans, who deduced it from a lengthy experimental investigation. This view, however, has been called in question, notably by Frankland and Appleyard (*Trans. Chem. Soc.*, 1893, p. 312). If their conclusion is right it provides a lethal weapon for the opponents of the electrolytic dissociation theory, for Ondemans's result is in full accordance with this much contested hypothesis. With a view to testing the accuracy of these rival conclusions, H. Hädrich has recently completed a research, the results of which, in his opinion, fully confirm the law of Ondemans. So the dissociation theory scores one point more. Hädrich's paper may be consulted in the *Zeits. Physikal. Chem.*, xii., pp. 476—497.

* H. R. Kempe's "Handbook of Electrical Testing," 5th edition, page 481.

THE BEST FREQUENCY FOR ALTERNATING CURRENT INSTALLATIONS.

This question is discussed by E. Kolben in the *Electrotechnische Zeitschrift*, February 8th. He says that to determine the best frequency, all the parts of the installation influenced by it must be considered; the generators, the transformers and the motors, as well as the system of conductors. The following phenomena, depending upon the frequency must therefore receive closer consideration :—

I. The relation of the hysteresis and eddy current losses to the frequency, and the consequent efficiency, heating, and cost of the generators, transformers and motors.

II. The increase of the resistance, the self-induction and the capacity of the conductors, with increasing frequency.

III. The influence of frequency on the parallel working of generators and the driving of motors.

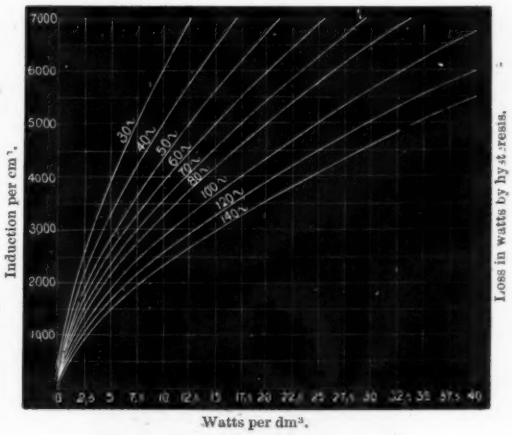


Fig. 1.

I. The hysteresis and eddy current losses depend on the frequency, n, and the maximum induction in the iron, B. According to the observations of Ewing, which have been verified by Steinmetz, the loss in watts per cubic decimeter of soft iron plates, ·5 mm. in thickness, is :

By hysteresis,

$$W_h = 0{\cdot}003\ n\ B^{1{\cdot}6} \cdot 10^{-4},$$

by eddy currents,

$$W_e = 0{\cdot}004\ n^2\ B^2 \cdot 10^{-8},$$

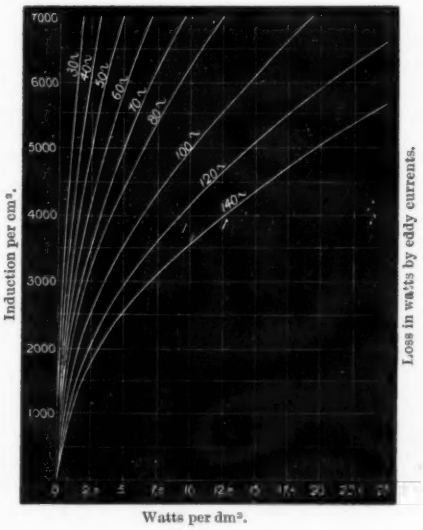


Fig. 2.

i.e., the hysteresis loss increases as the frequency and the 1·6 power of maximum induction of the iron. The eddy current loss increases as the square of the frequency and the square of the induction. In order to get a clear view of the absolute value of these losses in commercial armature and transformer plates, the losses from hysteresis and eddy currents are separately represented in figs. 1 and 2, and together in fig. 3, as functions of the frequencies and the induction of the iron. In drawing the curves the frequencies hitherto used in installations have been kept in view. These are 40, 50 and 70 ~ on the continent of Europe, 80 and 100 ~ in England, 120 to 140 ~ in America.

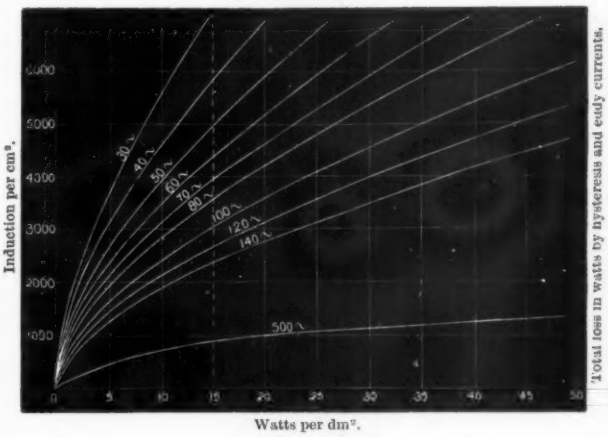


Fig. 3.

For the sake of completeness and of comparison, the losses in watts by hysteresis and eddy currents are given in figs. 4, 5 and 6, for frequencies from 10 to 30.

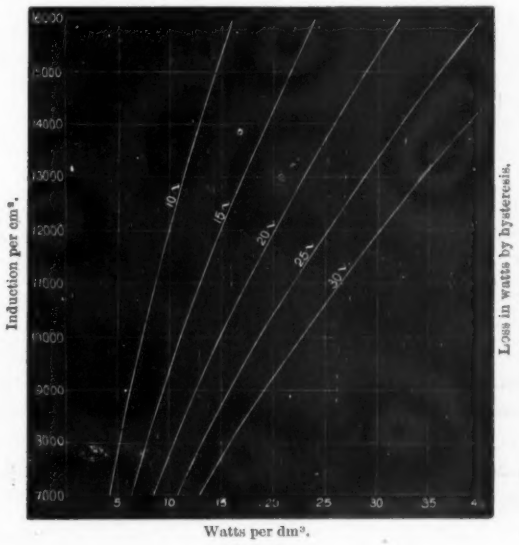


Fig. 4.

If it is desired to maintain the same loss in watts per unit volume, for all frequencies, the maximum value of the induction in the iron permissible, can be readily determined from fig. 3. Take, for example, the loss to be allowed as 15 watts per decimetre, then the maximum values of the induction in the iron are :—

For 10 ~ B =	14,500
30	7,100
40	5,850
50	5,000
60	4,450
70	3,950
80	3,600
100	3,050
120	2,700
140	2,400

Now, it is well known, that the section, S, of the core of an alternator motor or transformer, with a primary coil of N turns, and an electromotive force, E, can be calculated by the following formula :—

$$S = \frac{\sqrt{2}\ E\ 10^8}{2\ \pi\ n\ B\ N}.$$

That is to say, the section is inversely proportional to the product of the frequency and the density of the induction. Since, however, as can be seen from the curves, the induction does not require to be reduced in the same proportion as the frequency increases, a rise in the frequency means either a reduction of weight with the same loss in watts, *i.e.*, cheaper machines, or an increase in efficiency with the same weight.

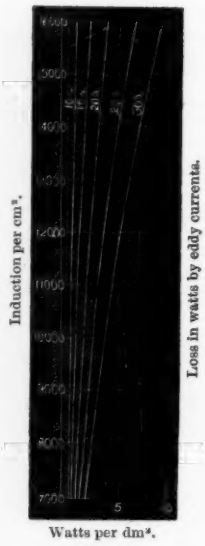


Fig. 5.

This raising of the frequency, of course, can only be carried up to a certain point, as overheating will take place when the radiating surfaces are too much diminished. For this reason, high frequencies are permissible for small machine and transformer units whose surfaces are proportionally large, such as those hitherto generally used in American systems with frequencies of 120 to 140 ~. In this system, every

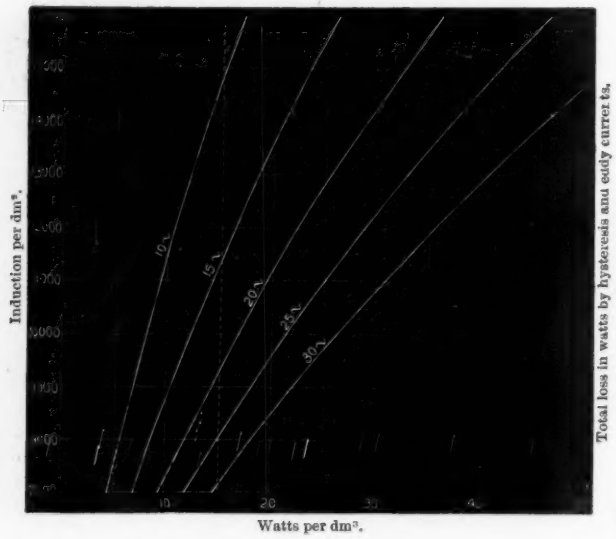


Fig. 6.

feeder is supplied from the central station by a separate machine, and every consumer is connected directly to the primary network by a small transformer. These transformers, of 0·5 to 5 kilowatts, have the high efficiency of 95 per cent. to 97 per cent. with full load, and absorb only a small amount of energy when running without load. For large units, such as are employed in European central stations, with parallel working of the machines, and large transformers in sub-stations, a frequency much over 60 ~ is superfluous, and for other reasons, which will be discussed further on, irrational, since nothing is gained in efficiency, and only a little in weight and cost.

II. The principal controlling factors, however, which make for the adoption of a low frequency, are certain phenomena, peculiar to the alternate current, which arise in the high and low tension conductors.

a. The increase of resistance in powerful secondary conductors.

b. The self-induction.

c. The capacity of the leads.

a. It was observed by Lord Rayleigh in 1886 that the true resistance of a conductor through which an alternating current is flowing, increases as the frequency increases. This is due to the fact that the current density is not uniform throughout the section of the conductor, but is greater nearer the surface than at the axis. If R is the true ohmic resistance of a copper conductor of d cm. diameter, the increased resistance, R_1, may be found with sufficient approximation for practical purposes by the formula :—

$$R_1 = R\,(1 + 7{\cdot}5\,d^4\,n^2\,10^{-7}),$$

that is to say, the increase of the resistance is proportional to the square of the frequency. In fig. 7. the percentage increases of resistance for different frequencies are graphically represented. From the curves it can be seen that for 30 ~ the increase of resistance for 20 mm. copper rods or cables amounts to only 3 per cent, while for 10 mm. wires it may altogether be neglected.

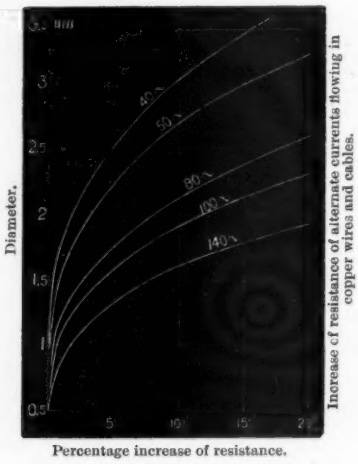

Diameter.
Increase of resistance of alternate currents flowing in copper wires and cables.
Percentage increase of resistance.

Fig 7.

With the American frequency of 140, an extended secondary netting of conductors is out of the question, as the extra fall of potential with cables of less than 300 mm². would amount to 25 per cent. It may be here remarked that the only way of obviating these evils is to use either flat cables, or round cables, with strands passing alternately from the outside to the core, and *vice versâ*.

b. The ohmic resistance of a system of alternate current conductors is increased by the self-induction combined with the capacity. If the coefficient of self-induction is L henries, and the capacity C farads,

$$R_1 = \sqrt{R^2 + \left(\frac{1}{2\,\pi\,n\,C} - 2\,\pi\,n\,L\right)^2}$$

and the current, J, resulting from an initial E.M.F., E, is

$$J = \frac{E}{R_1}.$$

This apparent resistance, R_1, the so-called "impedance," changes with the distance between the outgoing and return leads, the diameter of the wire, and the frequency, so that the ratio of the impedance to the ohmic resistance, the impedance factor, $\frac{R_1}{R}$, even for dimensions occurring in practice has considerable values, and the fall of potential may be extraordinarily increased.

A. E. Kennelly has determined (American Institute of Electrical Engineers, April 18th, 1893) the impedance factors for sine currents for different values of diameter of wire, frequency, and distance of conductors. The results for

conductors, 50 cm. apart, are shown in fig. 8. According to these curves, in a system of leads with wires of 7 mm. diameter and a frequency of 50 ~, the ohmic resistance would be increased about 25 per cent. With 140 ~, however, the increased resistance would be about $2\frac{1}{2}$ times the ohmic resistance. It is clear, therefore, that for the transmission of large amounts of energy over great distances a frequency greater than 60 ~ is not admissible.

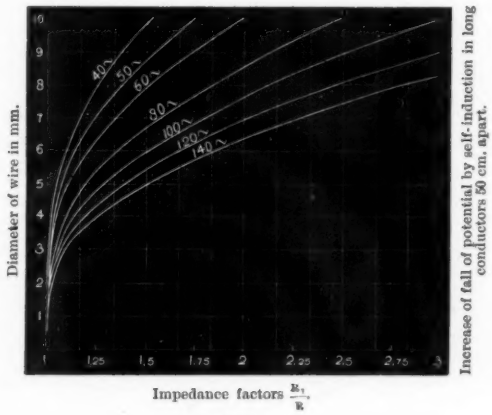


Fig. 8.

In the case of subterranean conductors, especially cables whose capacity is great, it may, of course, happen that the influence of the self-induction is neutralised by the capacity. The required condition can be obtained from the formula given above for the impedance.

$$\frac{10^6}{2\,\pi\,n\,C_1} = 2\,\pi\,n\,L,$$

where C_1 is the capacity, in microfarads. In such a special case, since C_1 and L are fixed, it is evident that only one value of the frequency, n, can be used, viz. :—

$$n = \frac{10^3}{2\,\pi\,\sqrt{L\,C_1}}.$$

c. The capacity of the line, in the normal cases of power transmission by air lines, is by no means so important as is generally supposed. Nevertheless, in order to reduce this influence to a minimum, a high frequency is undesirable. The capacity of a wire conductor of radius v cm., and mounted at a distance of d cm. from the earth on poles, amounts in dry weather, for 1 kilometre, to :—

$$C = \frac{0{\cdot}0217}{\log \frac{2\,d}{v}} \text{ microfarads.}$$

Thus an increase in the diameter of the wire makes only an inconsiderable increase in the capacity. The charging current, J, corresponding to this capacity, with potential of E volts is :—

$$J = \frac{2\,\pi\,n\,E\,C}{10^6}.$$

The charging current therefore increases with the frequency. For cables or conductors laid in canals, whose capacity is great (for rubber cables, for example,

$$C = \frac{0{\cdot}1}{\log \frac{D}{d}}$$

where d = diameter of the core, and D the external diameter of the insulation), the charging current has a relatively high value, so that generators, conductors, and motors are strongly influenced and loaded by it. In the case of air conductors mounted on poles, the charging current with 40 to 60 ~ is of little importance, as is evident from the following experiment which was made on the power transmission conductors from Bülach to the factory at Oerlikon. The conductors were 23 km. in length, were made up of 4 wires 4 mm. diameter, and mounted on wooden poles at an average distance of about 10 m. from the ground. In the high tension experiments with 25,000 volts, which were undertaken upon this line, the two conductors were connected at one end, so that one conductor of 46 km. in length was obtained. The capacity of the line calculated for 46 km. was :—

$$C = \frac{46 \times 0{\cdot}0217}{\log \frac{2{,}000}{0{\cdot}2}} = 0{\cdot}25 \text{ microfarads.}$$

From this was obtained with 42 ~ and 24,000 v. line potential, a charging current :—

$$J = \frac{2\,\pi\,.\,42{\cdot}24000 \times 0{\cdot}25}{10^6} = 1{\cdot}632 \text{ ampères.}$$

Actual experiment gave 1·65 ampères, with a consumption of 4,150 watts. This line transmitted about 400 kilowatts with a loss of only 10 per cent.; the loss due to the charging of the conductors was only 1 per cent., and the charging current was only about 10 per cent. of the normal current.

III. In the parallel working of alternators the frequency appears to be of little importance. There are in Europe, with a frequency of 40 ~, a number of installations in which parallel working can only be carried out by the help of artificial load resistances, while in other installations on the Continent with 70 ~, in England with 100 ~, in America even with 140 ~, parallel working is carried out with certainty without any such aids.

There is great difficulty, however, in making good motors for high frequencies. The theoretical number of turns, v, of a synchronous alternate current motor with p pairs of poles is with $n = v\,\frac{60\,n}{p}$. From this formula it is evident that it is an advantage to have a small number of turns, as it permits a smaller number of poles to be used. Since the current used when the motor is running without load is proportional to the number of poles, and is disproportionately great with small motors, the reduction of the number of poles is of great importance. The starting current with a large number of poles is also very great.

From what has been said, we are driven to the conclusion that, with the exception of cases of the transmission of very great powers to very great distances, a frequency of 50 to 60 periods corresponds best with the large claims of an economical installation with good efficiency, good regulation, and reliable working.

COST PRICE OF ELECTRICAL ENERGY IN CENTRAL STATIONS.

In a former article on the distribution of electrical energy at Cologne and Amsterdam (*L'Industrie Electrique*, No. 49, January 10th, 1894, p. 11), we blamed the central electrical energy stations for not publishing some of the results of working which might be reproduced in the technical journals, without being in any way prejudicial to those interested. In answer to our reproaches and regrets we have just received from the Elektricitäts Aktien-Gesellschaft, of Nuremberg, some very interesting particulars, which we will now sum up.*

The Nuremberg Electrical Company has, in the course of some years, established several central stations, six of which are very important: Barmen, Elberfeld, Hamburg, Hanover, Cologne, and Düsseldorf. These stations have already been described, so we shall not enter into this part of the subject here. We will merely mention that the central stations of Barmen, Hanover, and Düsseldorf, effect the distribution of electrical energy by means of continuous currents with accumulators, that those of Elberfeld and Hamburg employ continuous currents without accumulators, and that the central station of Cologne is the only one that uses alternating currents.

* The information sent to us is taken from an article published in the *Elektrotechnische Zeitschrift*, No. 1, January 4th, 1894. Some of the figures have been corrected in accordance with the particulars supplied to the same journal on February 1st, by M. Joly, manager to the company supplying gas, electricity and water to the city of Cologne, and by M. O. Gusinde, manager of the Central Municipal station of Hanover.

I.—Cost of Installation and First Establishment.

It is, in the first place, interesting to know the economic conditions under which the different installations have been established. The following table may enlighten us with regard to this point; it gives us the power of the installation in kilowatts, and the cost of first establishment per kilowatt available at the works.

Only the available power has been reckoned, including the accumulators, without considering the reserve power. These various amounts show considerable differences, especially as regards the expenditure per lamp capable of being supplied by the existing mains. To explain these differences we should have to examine the special conditions of each installation: the situation of the station, whether within or beyond the limits of the town, the ground rent, the inconveniences of noise and smoke which may be avoided in one installation and not in the other, &c. It is very difficult, not to say impossible, to make fair and correct comparisons between the expenses of first establishment of central stations, when we consider the number of circumstances that have to be taken into account.

Conditions of Establishment and Working in the Large Central Stations for the Distribution of Electrical Energy in Germany.

Details.	Barmen.	Elberfeld.	Hamburg.	Hanover.	Cologne.	Dusseldorf.
General Data.						
50-watt lamps capable of being supplied from the works	4,500	10,000	11,600	12,000	13,600	12,000
50-watt lamps capable of being supplied from the mains	6,500	12,000	12,000	23,000	24,000	23,000
Available power in kilowatts	225	500	580	600	680	600
Expenses of First Establishment.						
Installation capital, in francs	1,053,745	1,406,340	2,442,850	2,598,848	2,435,570	2,872,137
Specific expenditure, in francs, per kilowatt	4,683	2,812	4,211	4,050	3,575	4,775
" " per lamp	162·5	125	162	202·5	178·75	238·75
Receipts and Expenses.						
Duration of working, in years	5	5	4	2	1	1
Total receipts, in francs	123,686	238,566	578,585	335,063	282,158	282,010
Receipts per cent. of the capital	11·74	20·5	23·68	15·8	11·5	9 8
Total expenditure, in francs	43,122	90,201	137,465	94,747	105,465	79,011
Expenditure per cent. of the capital	4·9	6·41	5 62	4·46	4·07	2·72
Rough total profits, in francs	80,564	198,365	441,120	240,316	176,693	202,999
Profits per cent. of the capital	7·65	14·09	18·05	11·34	7·2	7
Expenses—Cost.						
Total energy, in kilowatt-hours produced	144,996	313,438	542,900	452,520	...	484,111
Total energy, in kilowatt-hours distributed	122,026	305,794	513,183	365,114	307,074	337,285
Efficiency of the mains per cent	84·16	97·5	94·5	80·69	...	69·68
Energy, in watt-hours, per kg. of coal consumed produced	229	...	325	482	...	406
Energy, in watt-hours, per kg. of coal consumed distributed	198	...	307	398	156	283
Salaries, in centimes, per kilo-watt-hour produced	16·9	12·6	9·3	8·9	...	8·4
Salaries, in centimes, per kilo-watt-hour distributed	20·1	13	9 9	11·1	15·1	12
Cost per kilowatt-hour, in centimes produced	29 7	28·7	25·3	20·9	...	16·3
Cost per kilowatt-hour, in centimes distributed	35·3	29·4	26·7	25 9	34·3	23·4
Mean selling price, in centimes, per kw.-h., including all expenses	101·3	94·3	112·7	91·7	91·8	83·5
Charge without deduction for the kw.-h., in centimes	91	91	...	92·5	87·4	108
Price per cubic metre of gas for a consumption above 3,000 cubic metres, in centimes	21·8	20	...	19 3	16·25	18·75
Coefficients of Utilisation.—Duration of Lighting.						
Number of 50-watt lamps installed	7,325	11,100	14,000	13,642	15,329	16,623
Maximum power utilised, in kilowatts	139	400	462	415	325	309
Ratio of the power utilised to the power available	0·61	0·80	0·79	0·48	0 50	0·51
Duration of lighting, in hours, per annum	325	569	693	529	422	419
Employment of Accumulators.						
Energy expended for the charge, in kilowatt-hours	59,573	...	194,733	...	...	279,506
" furnished by the discharge "	42,584	...	154,836	...	...	216,561
Industrial efficiency of the accumulators, per cent.	71·5	...	79·4	...	...	77·5
Ratio of the energy supplied by the accumulators to the total energy distributed, per cent.	35	...	42·3	...	...	62
Loss in the accumulators, per cent., of the total energy distributed	14	...	11	...	...	13

* The figures given for accumulators under Hamburg should evidently be attributed to Hanover.—Eds. Elec. Rev.

II.—Results of Working.

The figures in the accompanying table will enable us to make correct and very interesting comparisons. We will first examine the balance sheet of the receipts and expenditure after several years' working for some stations, after one year for others.

State of the Receipts and Expenses.—In all the six central stations the receipts have been greater than the expenses. In installations of this nature, we must reckon about 3·5 per cent. interest, and 4 per cent. for the sinking fund.

This last factor may be calculated as follows: 1·5 to 2 per cent. for the buildings, 4 to 5 per cent. for the boilers, engines and various apparatus, 6 per cent. for the accumulators, 3 per cent. for the mains, 8 to 10 per cent. for the various necessary arrangements.

It will be seen that on deducting the interest and sinking fund (about 7 per cent.) there still remain profits which may be estimated at 11 per cent. of the capital at Hamburg, 7 per cent. at Elberfeld, and 4 per cent. at Hanover. At Barmen, Dusseldorf, and Cologne, the expenses were just covered.

Various Expenses.—Cost price of the kilowatt-hour. We will now endeavour to find out the cost of the available kilowatt-hour. The table shows that the canalisations of the six stations examined give high efficiencies; two give even exceptionally high efficiencies, 94 and 97 per cent; it evidently depends on the capital expended in the first installation. As to the industrial efficiency of the station, *i.e.*, the ratio of the total available electrical energy at the terminals of the distribution board to the electrical energy available at the boilers, taking into consideration the quantity of coal burnt, it is not so high. To form a correct judgment, however, as to this point, we must know the nature and the calorific power of the fuel employed. We may also add that at Hamburg some new triple expansion steam engines of 5 to 600 H.P. have been installed, and that these allow of a better utilisation of the fuel than those previously in use.

The electrical energy produced at the works and dis-

tributed costs very little. The maximum amounts to ·343 fr. and the minimum to ·234 per kilowatt-hour supplied to the consumer, and to ·297 and ·163 respectively per kilowatt hour available at the works.

With regard to these last amounts, we added up the mean selling price per kilowatt-hour, including all expenses in each town. We deduced this price from the total quantity of electrical energy distributed and the sum total of the receipts. We have shown below the tariff for the kilowatt-hour without deductions and without any expenses for meters, branch-lines, &c., also the price of gas per cubic metre; these last particulars were obtained from an article in the *Zeitschrift für Elektrotechnik*.

The Employment of Accumulators.—The above figures show that setting aside the station of Barmen, the best utilisation of the coal, expressed in watt-hours per kg. of coal consumed, has been obtained at Hanover and Düsseldorf, two central stations possessing accumulators. But we need not enter into this subject here, as it has already been discussed. In the three stations examined, the industrial efficiencies amounted respectively to 71·5, 79·5, and 77·5 per cent.

Coefficients of Utilisation—Duration of Lighting.—We have only been able to obtain a few particulars as to the coefficients of maximum utilisation, or the ratio of the maximum power distributed to the maximum power available, and also as to the mean duration of the lighting. We should wish this part of the question to be more complete, especially as regards the annual coefficients of utilisation. It would have been much more useful to give mean coefficients of utilisation, rather than maximum coefficients.

Notwithstanding some omissions, which are generally inevitable in researches of this kind, we may say that the above figures will be of great use to the managers of central stations; and we hope soon to be in a position to compare them with those furnished by numbers of other central stations, so that we can deduce from them conclusions of general interest.—J. Laffargue (*L'Industrie Electrique*).

AN EASILY REMEMBERED RULE.*

By CARL HERING.

So many rules have been published giving the relative directions of the current and the lines of force or whirls surrounding it, that it now becomes necessary to apologise for introducing a new one. The apology in this case is the same as the one usually given, that the author believes it to be simpler and more easily remembered than the others. The present rule applies only to the direction of the lines of force encircling the wire and therefore does not refer to the direction of an induced current as in dynamos, or the direction of motion as in motors, for which the writer has found Fleming's well-known three-finger rule to be the best.

To remember the direction of the magnetic whirls around a current, one has only to remember that if the current flows like the ink from a pen (that is, out at the point), then the direction of the magnetic whirls around this current will be the direction of the circular motion of the whole pen in drawing these whirls as one would, naturally, representing them as a close spiral encircling the pen, and beginning as though one started to write the small letter "m" (magnetic lines). The accompanying sketch will show this more clearly. Although it takes more than a few words to state this rule it is really more simple than it appears, the only important point to remember being that one must draw the spiral as if starting to write a small letter "m" (magnetism) and not as if starting to write the letter "C" (current); when drawn in the latter direction the current represented by the pen will be the one induced by the generation of these lines, as in transformers.

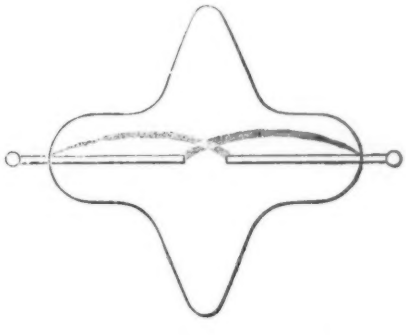
Some may prefer another rule, which is, that if the direction of the current is the same as the one in which one looks at a watch, then the magnetic lines will have the same direction as the movements of the hands of the watch. The reverse of this also applies; if the direction of looking represents the direction of the lines of force, the direction of motion of the hands represents the direction of the current producing these lines.

* *Electrical World.*

ELECTRIC DISCHARGE THROUGH GASES.

Prof. J. J. Thomson discoursed most brilliantly on "Some Properties of the Electric Discharge through Gases" at the Royal Institution on Friday evening last.

At the outset he dwelt on the association between many chemical and electrical effects. Of recent years the number of electrical phenomena which were inseparably connected with chemical action, had increased so much that they could venture to hope that some of the most important questions in chemistry and electricity would be recognised as being but different aspects of the same phenomenon. No phenomena were more suited to prove the connection between electrical and chemical effects than those which formed the subject of his remarks that evening, for here they had got matter in a state in which its laws were most accurately known, and the electrical effects were rendered more easy of accessibility. In other words, they obtained ocular and not circumstantial evidence of what was going on. The lecturer next went on to consider some of the phenomena connected with the transference of the electric discharge from gas to the electrode, and some properties of the discharge when it was confined in the whole of its course to the gas, and when it passed from the metal into the gas or from the gas into the metal. A great deal of information could be got on these points if they observed a discharge through a very long tube. He had observed, by means of a rapidly rotating mirror, the discharge in a tube 50 feet long. From the appearance in the mirror it was evident that the



luminosity started at the positive electrode, it then swept down the tube with enormous velocity; in fact, we understood the lecturer to say that the velocity was more than 100 thousand miles per second. When the discharge got near the negative electrode, its progress was checked, that is, there appeared to be a reluctance to enter the electrode, and the luminosity lingered for some appreciable time. This reluctance of the electric discharge to pass from the gas into a metallic electrode was further exemplified by means of experiments. In one of the experiments a bulb was used into which two electrodes projected; these

electrodes were connected to the terminals of a high tension alternating current transformer. The spark did not pass from one end of the electrode to that of the other, but followed the gas as long as possible, and impinged at the place where the electrode joined the glass bulb. This curious effect of a double arc will be seen in the illustration.

The difficulty electricity experienced in getting from a gas to the electrode depended a great deal on the nature of the gas and the electrode. The lecturer then proceeded to show this by means of experiments. Oxygen gave a strong positive electrification, while with hydrogen it was different.

The electric discharge from an oxidised copper electrode in hydrogen was negative till the oxide was reduced, when it became positive. Of the gases themselves he had found that oxygen gave a strong positive electrification, while with hydrogen it was different in various parts of the bulb.

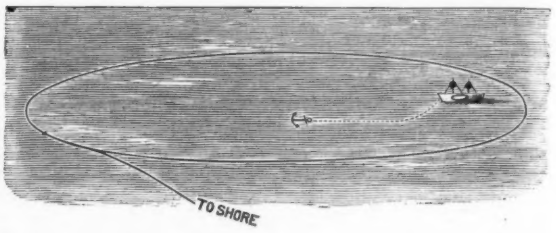
The transference from gas to electrodes, said the lecturer, was facilitated by chemical combination between the gas and the electrodes. They might go further and say that something of the nature of chemical combination between those two was necessary for the transference of electricity. Passing on to consider the discharge through gases without electrodes the lecturer deduced the conclusion that the conductivity of gases at a certain degree of rarefaction was greater than that of any metal, and almost infinitely greater, molecule for molecule. For the purpose of these latter experiments Prof. Thomson used the outsides of two Leyden jars, the insides of which were connected to a Wimshurst machine. A wire connecting them externally was made into a coil, in the centre of which were placed bulbs containing the gases to be experimented upon. When two gases were to be compared two coils were employed.

Another interesting experiment was that of a bulb placed inside another, the latter of which retained traces of mercury vapour; the discharge at first took place in the interior bulb, but upon increasing the density of the mercury vapour by slow heating, the discharge took place in the space between the two bulbs. The concluding experiment showed the influence of a magnetic field on the electric discharge.

ELECTRICAL COMMUNICATION WITH LIGHTSHIPS.

The establishment of electrical communication of lighthouses and lightships with the Postal Telegraph Service has been for some time the subject of enquiry and investigation in England and Scotland, and many lighthouse stations on shore have been thus connected; but the connection of rock stations and lightships has been prevented by the difficulties to be overcome, in the first case mainly by the difficulty of maintaining the armouring over a rocky and sometimes shoal bottom, and by the serious difficulty or impossibility of maintaining the cable where it goes up the rock; and in the second case by the difficulty of dealing with the moorings which are constantly "on the move." At the Kentish Knock, however, a system of moorings has been introduced, and which it is said is going to be extended to other light-vessels, and this arrangement, without saying that it will render the lightship unseaworthy, will be very expensive to lay, and impossible, practically, to examine from time to time, except at great expense, and will be very expensive to lift and renew.

The difficulty of the moorings has been more than once discussed in the Electrical Review, but the following sketch will illustrate an application of Mr. Charles A. Stevenson's system of communication by means of coils, and by which there is no connection between the shore and ship, the electrical connection being made by induction. A cable is laid from the shore out to the vessel, where it makes one or more turns round the area over which it is possible for the lightship to travel, which is, of course, governed by the length of her chain cable. On board the ship there is an insulated coil of a number of turns of thick copper wire and entirely insulated from the sea. On each of these two circuits there are the batteries and telephones. Now, it is evident from the sketch, that the two coils, that on board the ship and that on the bottom of the sea, must generally be close to each other, say, within 100 yards, and the coils, moreover, must always be in a strong magnetic field with respect to each other, as the one is always inside, so that very little battery power will be requisite. Mr. Stevenson has already made coils work at 600 yards *outside* each other with only eight turns on each coil, and five cells as a battery



power, the coils being about 200 yards diameter, so that it is evident that but a very feeble battery power will be necessary with the increase in the number of turns on board the lightship, and from the fact that they lie inside one another in place of outside, as in the Edinburgh experiments, which we have described in a previous issue.

PHOTOMETRY.

Capt. Abney's third and concluding lecture at the Society of Arts, on Monday night, was devoted mainly to colour photometry. It will be remembered that Capt. Abney's and Major-General Festing's colour photometer compares the visual intensity of two rays of different colour by placing two small patches of colour together, which are lighted from different sources.

Before, however, we pass on to describe Capt. Abney's third lecture, we will refer to a point in the second lecture, which was reported in our last issue. Captain Abney, in referring to the ether standard, spoke of it as being due to Messrs. Sugg. From enquiries which we have made, we find that it was a mistake on the part of Capt. Abney to refer to the "Ether-Argand" as theirs, it having been an outcome of Mr. Dibdin's Pentane Argand. The burner used was made at Mr. Dibdin's request by Messrs. Sugg and Co., but Mr. Dibdin rightly claims the parentage of both forms of standard.

In the course of experiments, Mr. Dibdin found that if ether was substituted for pentane in the 10-candle Pentane-Argand standard, a beautifully pure white light was obtained, having a visual intensity of *five* candles instead of ten. Mr. Dibdin called attention to this in the public prints some time back, and last winter the system was tried by Messrs. Cadett and Neall, photographic plate-makers, of Ashstead, Surrey. They pointed out that, for the very rapid plates, a standard of less intensity was required, and Mr. Dibdin accordingly asked Messrs. Sugg & Co. to construct a smaller burner on the same principle as the 10-candle. This they did, and the result is the 1-candle Ether-Argand, to which Capt. Abney referred.

The system is that air, when passed over ether, takes up a sufficient quantity to form a combustible gas, and this gas is burnt in a very small Argand burner, the top of the flame being rejected as part of the standard by the interposition of a "cut-off" screen, with the result that the portion of the flame below the screen yields a constant light, even though the height of the flame may be accidentally varied to a considerable extent. It is understood, however, that it should be used at a fixed height; the above fact being useful in so far that it is evident that slight errors of judgment, &c., in setting the height of the flame are immaterial.

This quality is most strikingly shown in the 10-candle pentane-Argand standard, where the height of the flame may be varied as much as 2 inches without affecting the visual intensity of the light passing under the "cut-off."

Returning to the third lecture, Capt. Abney described at considerable length the photometer due to him and General Festing. Passing on to consider the methods of varying

the intensity of light, the lecturer said a very useful plan in photometry was using an incandescent lamp with resistances inserted in the circuit, so that they could make the light bright or dark as required. One very great advantage in using the electric current was that they could read on a galvanometer closer than they could by the light; by the galvanometer they could tell exactly how much light was sent out. A practical application of this was shown to the audience. In a box was placed an incandescent lamp which illuminated a grease spot; by varying the resistance they were able to get more or less light to illuminate the grease spot. The box itself was of historical interest, from the fact that it was the method used during the last two eclipses to estimate the brightness of the corona. After speaking of the method employed by Prof. Thorpe in estimating the brightness of the corona, the lecturer then went on to speak of a new photometer on the shadow principle.

In concluding this lecture—which, as we have stated, was mostly descriptive—Capt. Abney said they were very apt to take as true all that they read in text-books, and he supposed a large number of his audience would consider that he was a perfect heretic when he said that the law of inverse squares, although true in reality, was not true to the eye. What he meant by this law was that a candle 1 foot from a screen would give a certain quantity of light, at a distance of 2 feet it would give a fourth, and at 3 feet one-ninth, and so on. Unfortunately, what might be true in theory was not true in practice, because one's eyes had a limit; therefore, in measuring faint lights they had to be careful to be quite sure that the law held good. By means of an experiment in which red, green and blue lights were thrown on the screen, it was found, on cutting down the luminosity of each equally, that red disappeared considerably before the green. Therefore, said Capt. Abney, the law of inverse squares was not true when they were dealing with faint lights.

REVIEW.

Traité de Télégraphie Electrique. By H. Thomas. Paris: Libraire Polytechnique, Baudry et Cie, editeurs, 15, Rue des Saints-Pères.

This is a fine work of 900 pages, written by an author of great capability, and it possesses the advantage over books of a similar nature, which have hitherto been published, of being closely up to date. Thus we have fairly full descriptions of the various forms of multiple telegraphs, in the shape of quadruplex and multiplex, the phonopore also coming in for a share of attention. The Baudot printer, naturally, is very fully described, indeed, no less than forty pages are devoted to this form of apparatus. The Munier multiple instruments are also very fully explained. Amongst the copying telegraphs we do not notice any mention of that of D'Arlincourt, which is certainly deserving of mention, from the simplicity of its synchronising mechanism.

The section dealing with batteries is hardly so good, or full, as the size of the book would warrant. In fact, it is decidedly poor, and the matter given is antiquated. In the section, dealing with underground lines, there is a great deal of fancy mathematics, interesting as mathematical curiosities, but as useless, from a practical point of view, as it is possible to conceive; indeed, this is not the only part of the book where useless mathematics are worked in. Generally speaking, we must confess that we are pleased with the compilation, which, however, will, of course, be far more appreciated in France than in this country, where it will only be of use to indicate how telegraph matters are carried on elsewhere.

ELECTRICITY AT MESSRS. DOBSON AND BARLOW'S MACHINE SHOPS.

Considerable attention has been given during the last few years to the application of electricity to workshop lighting and other industrial purposes, as well as to the construction of large municipal electrical works. So much success has attended the efforts in this direction, that now no modern mill or workshop can be said to be complete unless it is equipped at least with the electric light. Some of these private installations approach in size and even surpass in the amount of electrical energy generated, many of the central electrical supply stations which are now working in this and other countries. In this and other respects, perhaps the installation of Messrs. Dobson and Barlow, Limited, textile machinists, Bolton, will be of interest. The firm is one of the largest of its kind in existence, and employs between 3,000 and 4,000 men and boys.

Messrs. Dobson were among the pioneers of workshop electric lighting, and their experience of its merits and failings is unique, no trouble having been spared to make it a success.

Not only have they their shops lighted, but the firm has also a complete welding plant in daily use.

The electric lighting was first introduced on the incandescent system; but owing to this method not being altogether satisfactory in some of the departments, a system of lighting by inverted arc lamps, at that time in use on the Continent, was tried.

This method of lighting has been described by Mr. B. A. Dobson, in a paper read before the Institution of Mechanical Engineers, and who was instrumental in introducing it into this country. The lamp used is the Pieper inverted arc, suspended in a white enamelled reflector, and the advantages claimed for the system are that, the light being reflected from a white ceiling, it is thoroughly diffused, and casts no shadows. There is no glare, no unpleasant piercing rays to be seen, and every detail of shape and colour can be detected.

All the lamps are balanced by counterweights over pulleys, and the weight is run up to a pillar or wall, so that it will not interfere with the work carried on. This facilitates the lowering of the lamps for inspection, and renewal of carbons.

Considerable difficulty had to be met in finding room and power for the generating plant as it was installed, consequently the machines were fixed in scattered situations, sometimes unsuitable, and which was found to militate against the proper attention being given to the machines that they required. A new dynamo room has, however, just been completed, into which is being placed their lighting and welding dynamos. The room is the first storey of a new structure; it is 88 feet long, and 20 feet wide, with boarded flooring laid on cast-iron girders. To deaden the vibration the dynamos have been laid on oak blocks, which are 6 inches thick, and span the distance between the girders.

In the new room there are two dynamos of the compound "Castle" type, made by Messrs. J. H. Holmes & Co., Newcastle-on-Tyne. These machines have an output of 200 ampères each at an E.M.F. of 115 volts, when run at a speed of 840 revolutions per minute. They are arranged to run in parallel, and supply 100 16-C.P. lamps in the turning shop, 260 16-C.P. lamps in the roller beam shop, and 288 16-C.P. lamps and 8 inverted arcs in the planing shop.

These circuits are controlled from a switchboard placed by the machines.

This installation was their first, and originally put down by Messrs. Woodhouse & Rawson. Next to these machines is a Belgium dynamo made by the Compagnie Internationale d'Electricité. It is a shunt machine, calculated to give 250 ampères at 115 volts when run at a speed of 750 revolutions per minute, but has given 25 per cent. more current for months without undue heating.

It is of similar construction to the "Manchester," with one marked exception, which seems to be peculiar to continental manufacture. Its pole pieces are made on the "polar ring" principle, advocated by Dobrowolski, *i.e.*, the pole pieces forming a complete ring round the armature.

For this principle of construction is claimed prevention of sparking by decreasing the width of the neutral line of commutation. But the remedy would seem to be worse than the evil, since it is got at the expense of lines of force short circuited through the polar ring; and, moreover, the best English constructed machines built without the "polar ring" do not spark.

The installation of lamps run from this dynamo was fitted by Messrs. C. A. Parsons & Co., of Newcastle-on-Tyne, and comprises 28 Belgium arcs, 8 Woodhouse & Rawson arcs, and 67 incandescent lamps.

A slate base switchboard has been fixed by Messrs. Parsons, fitted with measuring instruments, and switches to control each pair of arc lamps as well as each circuit of incandescent lamps.

There is also a 4-pole dynamo by the same makers with an output of 450 ampères at 115 volts, and runs at a speed of 640 revolutions per minute. It is shunt wound, and, as in the last machine, its shunt resistance is varied by a resistance placed below its switchboard.

The bearings are self-lubricated by loose rings of larger diameter than the journal, turning on the shaft, and dipping into an enclosed well of oil below the bearing, which is found exceedingly efficient.

Four sets of brushes are used.

The machine supplies current to 60 inverted arcs and 95 incandescent lamps. The arc lamps are controlled in pairs from a switchboard by quick-break switches, and all the arcs in the works are provided with resistance and switch placed in a convenient place near the lamps.

The offices are lighted by about 170 incandescent lamps, and can be supplied either from the dynamo room, or from a separate plant working in the basement of the offices. The plant consists of a Woodhouse & Rawson dynamo driven by belting from the fly-wheel of an inverted engine of Messrs. Browett, Lindley & Co.'s make, Patricroft, Manchester.

The engine runs at 315 revolutions per minute with extreme steadiness, and its bearings are fitted with lubricating arrangements for very long runs.

The office lighting is controlled by two-way switches, so that any circuit can be supplied from either supply. The current taken from both supplies can be measured, and the E.M.F. of either can be noted in both dynamo rooms.

In addition to the machinery already mentioned, there is a 6-pole Thomson-Houston alternator in the main dynamo room used for welding purposes. It gives 200 ampères at 300 volts when run at a

speed of 1,050 revolutions per minute, and will absorb 80 H.P. It is separately excited by a continuous current machine, driven from its own armature shaft at a speed of 2,100 revolutions per minute. The output of the exciter is 40 ampères at 110 volts. The switchboard is fitted with suitable instruments and switches, through which the current is passed to the welding and brazing apparatus in the works.

The character of the machinery made by the firm, necessitating long lengths of shafting and bars of various sizes and sections, offers considerable scope for the application of electric welding, and they very early made experiments with a view to its introduction.

The trials made with various apparatus led to the laying down of one of the Thomson-Houston 40A *welders*, which will take a shaft up to $2\frac{1}{8}$ inches diameter.

The welder itself consists of a strong iron frame, weighing over a ton, into which the two shafts to be welded together are tightly clamped end to end.

The current is passed from one clamp of the welder to the other, through the iron shafts undergoing the process, and, as is well known, owing to the greater resistance which is opposed to the current at the junction of the two ends, heat is generated, which goes on increasing until the joint is hot enough to form a complete weld. The shaft or bar is then taken from the welder and hammered down to the proper diameter, and when having received the finishing strokes, the weld is so good and perfect that it is difficult to perceive where it really is.

It may be interesting to know that to weld a $2\frac{1}{4}$ inch shaft it requires a current of about 25,000 ampères, more or less, according to the time allowed, at an E.M.F. of about 2 volts. This represents 67 H.P. for two minutes time. It would be impracticable to generate directly such large currents at equally low E.M.Fs., so the current is reduced by a transformer placed close to the welder, from 300 volts as generated by the alternator to 2 volts. Another welder of half the capacity of the above we saw at work rounding up bars $\frac{3}{4}$-inch square at places to form journals. In less than 30 seconds heat sufficient was attained to complete the process by the hammer. Close by this welder is a smaller one used solely for brazing brass nebs on to the flyers of the card-room frames. All the apparatus is at some 200 yards distance from the dynamo room, and the current is transmitted by a 37/14 cable to the transformers.

The exciting current of the alternator is also led up to a variable resistance frame, which is under the control of the man in charge of the welder. This resistance is used to vary the E.M.F. of the alternator, in order to prevent the sudden rush of current through the shaft in process when it is first switched on, resulting in great strain to the machinery and engine, and also to humour, as it were, the weld as it is being formed at will.

Fuses are also inserted to cut off the current should the latter, through some inadvertence, rise to a point liable to injure the dynamos or transformers.

The gearing of the dynamo room has been carried out in a very substantial manner. The main shaft is 5 inches diameter, decreasing down to 3 inches, and is driven from a compound engine on the ground floor by 12 $1\frac{1}{2}$-inch ropes. All the machines, except the two "Castle" dynamos, are driven from separate countershafts fixed in one straight line. Loose pulleys are provided on the main shaft, so that any countershaft with its driving belt can be stopped when not required. The loose pulleys also run on sleeves, which avoids all friction between the pulleys and the shaft.

The main shaft runs at 250 revs., and all its bearings are lubricated, as well as those of the countershafts, by pumps driven by small bands from the shaft itself, and were fixed by Messrs. Jno. Musgrave and Sons, Bolton.

The power is developed by a compound vertical condensing engine, made by Messrs. Musgrave & Sons, and will develop 350 I.H.P. at a speed of 140 revs. per minute.

It is made after Fleming & Ferguson's patent, with the two connecting rods driving on to one crank, which is intended to give a more equable and better rotative power to the engine. Its motion is very steady; not a flicker can be detected in the lights, and the engine seems eminently suitable for electric lighting purposes.

The engine works silently, and is throughout of the best design and workmanship. The same may be said regarding all the machinery and apparatus of the installation, and that the lighting is giving the firm complete satisfaction is proved by the fact that they have entrusted Messrs. Laycock, Hill & Co., Manchester, with an order to fix an additional 120 inverted arc lamps, and about 1,000 incandescent lamps.

To supply the extra current, an "Elwell-Parker" dynamo will be laid down, made by the Electric Construction Company, Wolverhampton. We may say that the whole of the electrical apparatus is under the supervision of the firm's electrician, Mr. J. Platt, to whom we were much indebted during our visit.

ELECTRICAL COMMUNICATION WITH LIGHTHOUSES AND LIGHT-VESSELS.

The Royal Commission, in their second report, say that since the issue of their first report they have made a further tour of inspection of lighthouses and light-vessels. The report reads as follows:—

"On July 10th, 1893, we assembled at Glengariff, Bantry Bay. On the following morning we embarked on board the steamer *Moya*, which was placed at our disposal by the Commissioners of Irish Lights, and inspected the Bull Rock and the Fastnet. Leaving the *Moya* at Baltimore, we proceeded to Cork, and thence to Kingstown, where we embarked on board H.M.S. *Enchantress*.

"On the morning of July 13th we proceeded to the Isle of Man, landed at the Chicken Rock Lighthouse, and, passing Langness Lighthouse and the Bahama Bank Light-vessel, anchored in Ramsey Bay. On the following day we crossed from the Isle of Man to Bangor, county Down, passing the South Rock and Skulmartin Rock Light-vessels and Mew Island Lighthouse. On July 15th we proceeded to Lamlash, landing on the way at the Maidens and Ailsa Craig Lighthouses. After having visited Pladda Island Lighthouse, we landed on July 17th on Sanda Island and Rathlin Island, inspecting the lighthouses on those two islands, and anchored for the night in Lough Foyle. From Lough Foyle we proceeded to Oban, after having inspected the lighthouse on Inishtrahull Island, and from Oban we steamed through the Sound of Sleat to Stornoway. Returning to the mainland, we anchored at Loch Inver, and visited the Ru Stoer Lighthouse, and on July 24th we left Loch Inver for Longhope in the Orkney Islands, whence we paid a visit to the Cantick Lighthouse and to the Look-out Station of the Commissioners of Northern Lighthouses on Brough Ness, opposite to the Pentland Skerries Lighthouses. On July 26th we inspected Stroma and disembarked at Scrabster. Then proceeding south by train to Seahouses, we embarked on board the Trinity House steamer *Argus*, which conveyed us round the Farn Islands. The tour of inspection ended with the visit to the lighthouses on those islands.

"We re-assembled in London in September, and have since held several meetings.

"Although the general question of signalling had not been directly referred to us, it appeared to be so intimately connected with the subject of electrical communication that we felt ourselves justified in considering it, and in our first report we stated that in cases 'where the distance from the shore is not great, an improved system of distress signals (distinct from the usual fog signals) might, both at rock stations and on light vessels, prove an effective temporary substitute for the more costly expedient of electrical communication.'

"This view has been confirmed by the experience which we gained during our last tour of inspection, and we are now prepared to go further and recommend that the general lighthouse authorities should be invited to consider the subject with the view of instituting a universal system of visual and sound signals at all the various light stations on the coasts of Great Britain and Ireland.

"A member of the commission, Sir Edward Birkbeck, having occasion last spring to visit the United States of America, we requested him to take the opportunity of enquiring into the systems of coast communication in force in Canada and the United States.

"On his return to this country, Sir Edward Birkbeck submitted to us a report, a copy of which will be found in the appendix. From that report it will be seen that, while both Canada and the United States possess an efficient system of electrical communication round their coasts, none of the light vessels belonging to those countries had been electrically connected with the mainland.

"We have received and considered particulars of a number of inventions for effecting electrical communication between light-vessels and the shore, but none of these are, in our opinion, preferable to the *Sunk* system which is now being applied to the Goodwin (North Sand Head) and Kentish Knock Light-vessels.

"We have again to express our obligation to the Admiralty for the loan of H.M.S. *Enchantress*, and to the Trinity House, the Commissioners of Irish Lights, and the Commissioners of Northern Lighthouses for the assistance which they have rendered to us.

"Recommendations.

"We recommend that electrical communication by aerial wires be established without delay between the telegraphic system of the country, and the following *Shore Lighthouses and Lighthouse Stations.*

Name of lighthouse.	To be connected by telephone with	Estimated cost (approximate).
		£
Falmouth Harbour	Portscatho C.G.S. ...	160
Souter Point	Whitburn C.G.S. ...	100
Montrose (Scurdy Ness) ...	Usan C.G.S.	85
Covesea (Skerries)	Lossiemouth P.O. ...	83
Tarbet Ness	Portmahomack P.O. ...	55*
Look-out Station at Brough Ness for Pentland Skerries Lighthouses.	St. Margaret's Hope P.O.	233
Fair Isle (North end) ...	Fair Isle P.O.	128
Sumburgh Head (Shetland Islands).	Sumburgh P.O.	65
Cape Wrath	Durness P.O.	20*
Ru Stoer	Stoer P.O.	20*
Rhynns of Islay (Oversay Island).	Bruichladdich P.O. ...	330
Turnberry	Maidens P.O.	48
St. Bees	St. Bees P.O.	76*
Langness	Castletown P.O.	103
Menai	Beaumaris P.O., and Lifeboat Coxswain's house at Penmon.	72
South Stack	Holyhead C.G.S. ...	15
Galley Head	Dunny Cove C.G.S. ...	150
Loop Head ... ... } Kilcradan Point ... }	Carrigaholt P.O.	61*
	Total	£1,804

* If Admiralty wire is used

"It is with regret that we have decided to confine our recommendations in this report to shore lighthouses, but, until more has been done towards effecting the connection of those light vessels and lighthouses, which were selected in our first report as having the strongest claims to immediate attention, we hesitate to add to the list of light vessels and island and rock lighthouses, with which we consider that electrical communication should be established."

APPENDIX.

Report of Sir Edward Birkbeck on the System of Coast Communication in Canada and the United States.

I have the honour to report that, in accordance with the desire expressed by the Royal Commission on Electrical Communication with Lighthouses, &c., at their meeting held on March 20th, I proceeded, after the termination of my official visit to Chicago, to obtain, both by enquiry and by personal inspection, some information in regard to the telegraphic and telephonic system of coast communication now in force on certain portions of the coast of Canada and the United States.

The request addressed by the secretary of the Royal Commission to the Colonial and Foreign Offices that those departments should ask that facilities might be given to me by the Governments of the Dominion of Canada and of the United States, secured for me great assistance in my work of investigation.

Canada.

On my arrival at Ottawa, Mr. William Smith, Deputy Minister of Marine, gave me a most exhaustive explanation of the working of the coast telegraphic system of the Dominion. He was desirous that I should visit the life saving station on Sable Island, but thought it still more important that I should inspect a first-class lighthouse signal station commanding, during the navigation season, the largest amount of passing shipping.

The ss. *La Canadienne* was therefore ordered to meet me at Dalhousie, on the coast of New Brunswick, and to convey me to any portions of the coast that I desired to visit. I accordingly proceeded from that place early on the morning of May 25th in a north-easterly direction up the Gulf of St. Lawrence, passing the lighthouse signal stations on Macquereau Point and Cape Despair, and landing the same evening at Cape Rosier, a first-class lighthouse signal station.

Cape Rosier Lighthouse.—This lighthouse, which was established in 1858, is situated on a low cliff, and has a fixed white light 136 feet above high-water mark, with a range of visibility of 17 miles. The position is one of great importance for a signal station, and a large amount of shipping passes within signalling distance, bound either to or from Europe, Nova Scotia, or the United States, including, in the summer season, steamers proceeding through the straits of Belle Isle to Quebec and Montreal.

The lighthouse keeper at this station receives $800 per annum, and has to pay his assistant out of this sum. He is allowed to employ more than one assistant if he desires, but he must do so at his own cost.

During the time the navigation is open—generally from about April 1st to December 10th or 20th—the keeper and his assistant are responsible for the performance of the following duties:—

1. Lighting and cleaning the lamps.
2. Managing the boiler and engine for sounding the steam horn.
3. Painting the inside and outside of the lighthouse.
4. Taking entire charge of the telegraph (Morse) instrument.
5. Reporting to Quebec twice a day the state of the weather.
6. Reporting all ships passing the station.
7. Telegraphing for tugs to assist disabled vessels.
8. Forwarding any public or private telegrams which may be handed in.

Private messages handed in can be paid for either by the sender or receiver, and at some of the signal stations a very considerable amount of telegraph business is transacted during the summer months for trade purposes.

The lighthouse keeper's son had charge of the telegraph instrument, and the call bell is placed within hearing of the principal room used by the family, the instrument being in a small room on the ground floor. I inspected everything connected with the telegraphic portion of the keeper's duties, and found all in perfect order.

At night we steamed past Fame Point Lighthouse Signal Station, and proceeded to the Island of Anticosti, situated 65 miles from the mainland of the Province of Quebec, 107 miles from Newfoundland, and 40 miles from the coast of Labrador. The island is connected by cable with the mainland near Cape Rosier, and also with the coast of Labrador.

West Point Lighthouse.—I landed at West Point Lighthouse Signal Station, at 4 a.m., on May 26th, and inspected that lighthouse, which was established in 1858, and is situated on low land. It is furnished with a fixed white light 106 feet above high water mark visible 15 miles.

This is one of four first-class lighthouse signal stations, all situated on the south-west coast of the island. They are much needed on this dangerous coast, and are of great importance both as signal stations and for furnishing reports regarding the weather, and also regarding the state of the ice at the beginning and end of the navigation season.

The lighthouse keeper at West Point has two assistants, both paid by himself, with duties similar to those at Cape Rosier Lighthouse, except that a large gun is used in foggy weather instead of a fog-horn.

The signal station at Heath Point Lighthouse is the most important of the four for signalling purposes, but on inspecting the return of commercial messages handed in during the year at West Point Station, I found numerous entries proving that even at that most out-of-the-way station coast communication is of importance to the trading community.

A westerly gale, accompanied with snow and rain, made it impracticable to land at the East Cape Lighthouse Signal Station, but I was informed that the arrangements there are similar to those at the West Point Station.

The Canadian Government have established a complete and thorough system of telegraphic coast communication, and have also provided cable communication with every island of importance with the exception of Sable Island, which will be connected in due course. The telegraphic, instead of the telephonic, system has been adopted on account of the number of commercial messages which have to be sent, and the long distance which the messages have to be transmitted.

Many of the Canadian light-vessels have to be moved from their stations during the winter on account of the ice, and the question of cable communication with them has not been taken in hand.

The following statement was prepared for me by the Telegraph Department at Ottawa:—

"It is the practice of the Government Telegraph Service to operate its lines locally through district superintendents acting under instructions from the head office at Ottawa, as different conditions are found to exist in the different sections, and the requirements of the service can best be ascertained by local supervision.

"A book of rules for the guidance of the *employés* generally was issued in 1889 after the working of the entire system for several years had developed what was most advantageous and best calculated to facilitate the business of the service.

"In the matter of repairs. On land lines less than 200 miles in extent a general lineman is employed, whose duty is to go over the line periodically, and, with assistance when needed, put the whole in good order. In case of an interruption, the agent at the nearest office goes, or sends some one, to make temporary repair. Permanent repair is made by the lineman as early as practicable.

"As regards the maintenance of cables. All tests and repairs should, as far as practicable, be made by, or under the supervision of, one electrician, in order that the behaviour of, and conditions obtaining in, the different lengths may be followed up and understood by him. This practice has as closely as possible been adhered to by us.

"Sometimes a cable is known to have been seriously damaged by ice grounding on the shore ends, just about the time of an interruption occurring. In such case the local officer is authorised to pick up and examine the cable at the point in question, and to make such temporary repairs as he can by removing the armour wires, and in the most convenient way re-insulating the conductor should the latter be found exposed. As an instance in point, this was done at South-west Point, Anticosti, by our district superintendent, Mr. Pope, last month; and we have had uninterrupted communication which would otherwise have ceased until a new piece of cable could be spliced in.

"The ss. *Newfield* has been provided with the necessary appliances for raising, repairing, and relaying the cables in the gulf, and is always called upon for the making of permanent repairs.

"In event of a fault or break occurring whose whereabouts is unknown, the electrician from headquarters proceeds with the *Newfield* as early as practicable to locate the trouble and effect repairs.

"In the river St. Lawrence and in the lakes a tug boat, with sometimes a scow accompanying, is temporarily hired for the work of laying and repairing."

United States.

On Wednesday, May 30th, I called on Captain Charles A. Abbey, Inspector of Life-Saving Stations for the United States, at his office in New York.

Captain Abbey, who had been instructed by the Government at Washington to render me assistance during my visit, gave me all possible information respecting the telephonic service at the life-saving stations, as well as regarding the life-saving service itself.

In accordance with the suggestion of the United States Government, which I received through Sir Julian Pauncefote, I proceeded on the following morning with Captain Abbey to the coast of New Jersey State. We landed near Sandy Hook, and went thence by rail to Seabright Life-Saving Station.

It is important to observe that with the exception of the 10 stations on the Pacific coast, and those round the shores of the great lakes during the season of open navigation, the staff at the life-saving stations are, from May 1st to September 1st, all disbanded, the keeper alone being left in charge to work the telephone.

Orders had, however, been given by the United States Government to summon the surfmen at Seabright Station, in order that I might see everything in full working order.

Seabright Station.—I found this first-class station thoroughly organised and fully equipped in every detail. A very commanding place of look-out is provided on the roof, from which vessels in distress can be seen for a considerable distance, and telephonic communication can be effected with any one of the stations on the coast within 70 miles, by means of switches.

The telephone is placed in the keeper's room, but the call bell can be heard in all parts of the building, and is immediately answered by the person on duty. Practical tests were carried out in my presence at this station.

The keepers were loud in their praises of the advantages of the system for life-saving purposes, and stated that in the winter, distant stations are often warned in advance to be prepared for an emergency. The wire is carried on iron poles from the stations to the nearest system of wires—generally following the coast line—and where telegraph poles are not already available, iron ones are erected in close proximity to the shore, and to the life-saving stations on either side. The cost of running a wire from station to station is

on an average (according to information given me by the District Superintendent of Telephones), say $75 a mile, without the instruments.

Great importance is attached to the principle of running the wires direct from station to station, and not using existing lines many miles inland, and then returning to the coast, as has been done in many cases in England, thus making it necessary to call up the postmaster at night.

The United States Government allow the station telephones to be used by the general public in cases where there is no telegraphic office near, and messages are forwarded by the station keepers to the telegraph offices, payment being collected from the receivers of the messages.

The surfmen at each station—six in number, in addition to the keeper—patrol the coast day and night in either direction in a similar way to the coastguard-men, but at present there is no means for the patrol to call the immediate attention of the station and report a vessel in distress, and he may have three or four miles to wade through deep snow or sand to reach the station. I think that a great advantage would be gained if an arrangement was provided at stated intervals enabling the patrol to touch a "button," and thus warn the station to prepare for immediate service, and the surfmen informed me that such a system would add greatly to the efficiency of the life saving service, as the patrol often arrives at the station exhausted and almost unfit to go out in a lifeboat. Captain Abbey entirely endorsed this opinion.

Among other duties performed by the surfmen when on patrol in out-of-the-way districts is carrying letters in order to expedite their delivery.

I visited three other stations, viz.:—

1. Monmouth Beach.
2. Long Branch.
3. Deal.

The arrangements, so far as coast communication is concerned, at these and at all the other stations, are very similar to those at Seabright, which I have described.

I may add that the system of telephonic communication in connection with the life saving service on the shores of the great lakes during the navigation season is of an equally efficient character, and the necessity for this is apparent when the extent of the lake trade is considered, the annual import and export tonnage for the port of Chicago alone, on Lake Michigan, being larger than that of New York.

No cable communication from the shore to light-vessels has yet been established, but wires are laid to the electric buoys wherever they are placed, no ships being allowed to anchor near them.

I have, however, reason to believe that the United States Government are about to consider the desirability of cable communication between the mainland and some of the light-vessels and rock and island lighthouses, with none of which does communication at present exist for life saving purposes.

In conclusion, I would remark that the Canadian telegraphic coast communication arrangements appear to me to be carried out in a most efficient manner, and to be of great use to the Government and general public, and considering the many duties which the lighthouse keepers have to perform with so small a staff to assist them, it was most striking to see the great interest they take in their extra work of telegraphy, and how cheerfully they perform it.

These facts lead me to venture to think that the Royal Commission will have no hesitation in recommending that more lighthouses be telephonically connected with the Post Office system on certain parts of our coasts.

From the inquiries I made in the United States, at the Government establishment at the World's Fair under Lieutenant Charles H. McLellan, from the information I gained from Captain Abbey, and from my inspection of the stations on the New Jersey Coast, to which I have referred, I am convinced that the system of telephonic communication now in force in the United States is a very admirable one, and I am of opinion that the maximum of efficiency would be secured if in due course the system of direct lines running along the coast could be adopted in this country, instead of the zigzag system of communication through inland post offices, which necessarily at night involves loss of time, a matter in some cases of vital importance.

I would suggest that the thanks of the Royal Commission should be conveyed to the Governments of Canada and the United States for the courtesy which was shown to me, and for the great assistance and facilities granted to me in the inspection, which I had the honour to make on behalf of the Royal Commission, of the systems of coast communication in those two countries.

The thanks of the Commission are in particular due to the following officials:—

1. Mr. William Smith, Deputy Minister of Marine and Fisheries, Ottawa.
2. Mr. Summer I. Kimball, general superintendent of the United States life saving stations, Washington.
3. Captain Charles A. Abbey, inspector of life saving stations, 24, State Street, New York.
4. Lieutenant Charles H. McLellan, in charge of the United States life saving exhibits at the World's Fair, and assistant inspector of the Fourth District.
5. Captain Bélanger, in command of the Canadian Government ss. *La Canadienne*.

(Signed) Edward Birkbeck.

June, 1893.

Commercial Cable Company.—The executive offices of the Commercial Cable Company are now located in the new Postal Telegraph Building, 253, Broadway, New York.

ARC LIGHTING.

By E. Tremlett Carter.

(*Continued from page* 299.)

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XV.

19. *Alternate Current Lamps for Parallel Working.*—There are two cases which arise in practice where it is desirable to work arc lamps from an alternate current system at constant voltage. In the first, where single arc lamps of considerable candle-power are to be used for public lighting by means of power supplied from the high-pressure mains, the lamp is placed on the secondary circuit of a specially designed transformer. In the second case, where a private consumer requires to run one or more arc lamps upon his lighting circuit in conjunction with glow lamps, there are several courses open, but the usual plan is to place the arc lamps in pairs across the secondary circuit of the house transformer; or, if only one lamp is required, this must be placed in parallel with the glow lamps, and must have its surplus voltage choked off in some manner. A third case might arise, where lamps might be run in parallel on a low pressure circuit by means of alternating currents; but this case is not yet in practical operation, and does not offer advantages which are likely to lead to its introduction. The only merit which, as far as the working of the lamp is concerned, such a system would have would lie in the use of alternating currents; for these currents would supply a tremulous motion to the parts of the lamp which, if it were well-designed, would prevent them from sticking. The merit would not compensate for numerous disadvantages.

Considering the first-named system—that which is used for public lighting from high pressure mains—we find that the lamp is provided with a transformer which supplies it with power at the requisite voltage, and which will maintain a constant voltage whatever the condition of load due to the working of the lamp may be. The lamp must be designed to give a steady light under such conditions. Besides the ordinary precautions consequent upon the use of a rapidly alternating current (see section 17), the conditions of parallel working laid down in section 18 must be followed. If the transformer is close to the lamp, as is usual, there will be no drop between the two, except in so far as any special rheostat or choking coil is introduced for the purpose of causing a drop; and the whole of the difference between the voltage required by the lamp and that given by the transformer must be adequately choked off by this special device. The self-induction effect of the alternating current renders it practically possible to replace an ordinary resistance frame or coil by a highly inductive resistance, which will waste but a very small amount of power in proportion to the number of volts which it will absorb. Such a device is called a *choking coil*, and is commonly used in series with arc lamps which are run on a constant voltage system. It may be constructed in two ways; either to give a fixed inductance, or to give an adjustable inductance, where the other conditions of the circuit remain constant. The former kind is usually constructed of a closed iron ring, shuttle-wound with a single coil of insulated wire of many turns, which is placed in the circuit of the alternating current. The latter kind usually consists of a straight hollow bobbin, wound with several turns of insulated wire, the inductance of the coil thus formed being varied by inserting or partially withdrawing a laminated iron core in the centre of the bobbin. The first-named kind is the simpler, cheaper, and more economical, and if properly designed at the first to suit the lamp on which it is to work, will be found as satisfactory as the adjustable kind. It is always possible to effect a rough adjustment of the ring-shaped choking coil, if the impedance is required to be altered, by winding on more turns, or unwinding some turns on the coil. In designing a choking coil for arc lamps, it is of the first importance to remember that the object is not the mere absorption of volts, but to provide an arrangement which will rapidly alter in the amount of voltage which it will absorb when the current changes a small amount. This is a vital point, and it directly affects the proportioning of the iron core; for the section of iron

must be such that, under normal conditions, the magnetic induction does not approach saturation, but is worked on a magnetic cycle, which lies wholly on the steepest part of the induction curve. If a choking coil is working with its iron fully saturated, its inductive resistance to an increase of alternating current is practically negligible, the permeability of the iron being reduced nearly to zero for *positive increments* of current. The increase of voltage at the ends of such a coil, when the carbon rods should come into contact, would be due only to the copper resistance of the coil, and would be too small to prevent a very large current passing. On the other hand, if the normal cycle of induction does not bring the iron core anywhere near to the top of the steep part of the magnetisation curve (this curve ought to be familiar to every electrical engineer), the slightest increase in current will produce a proportionately greater number of magnetic lines in the core, and will thus cause the self-induction and impedance of the coil to become greater; the tendency therefore will be to prevent too great a rise of current strength. Careful attention to this point will render two advantages: it will make a more economical choking coil, and it will give a better-starting and steadier light.

There is another point of considerable importance in connection with the absorption of auxiliary—it is not here correct to call them surplus—volts, namely, the choice of the value of the impedance and of the actual number of auxiliary volts which will normally be found at the terminals of this impedance. This is a matter which, in every system of parallel working of arc lamps, has been very much ignored in practice. Engineers have in general adopted a certain value of pressure for their mains, have wound their lamps with a certain resistance which is not selected to suit the pressure, and have thrown into the circuit as much resistance or impedance as will make the current just right for the lamp. The practice is haphazard, and because it is so it often leads to unsensitive and faulty conditions of working. This is as true for lamps which are fed with continuous currents as for those running on alternators; but the author has reserved the investigation for this section, because, on account of the fact that choking coils do not absorb much energy while equivalent resistances do, it is not found uneconomical to follow the results in alternate current lamps, while it might be uneconomical to do so where continuous currents are used. We shall now discuss the conditions of choking coil impedance or rheostat resistance, which will give the most satisfactory steadying results in parallel working.

Steadiness depends upon the variation of the effort of the shunt solenoid, when a variation of pressure at its terminals arises on account of a change in the resistance of the portion of the main circuit which is intercepted between the shunt terminals. This portion usually consists of the main coil, the carbons, and the arc itself; but the sudden changes in resistance which are required to affect the regulation occur in the last-named portion alone. There is, however, a gradual and steady diminution of resistance of the carbon rods, owing to consumption, which will continuously decrease

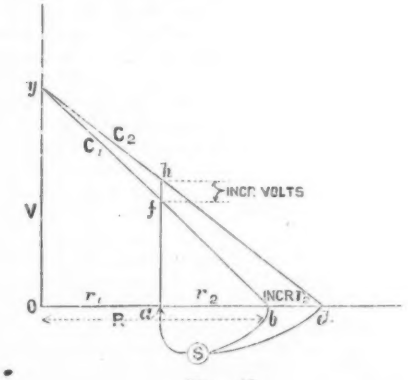

Fig. 46.

the intercepted resistance, unless compensated. Let the arrangement of the circuit on the constant pressure mains be represented by fig. 46, in which o, y, gives the number of volts on the mains, o, a, the ohmic value of the choking impedance which is placed in series with the lamp and outside the shunted part of the circuit, o, b, being the minimum value of the total resistance across the mains, to which is sometimes added the temporary increment, b, d, due to the lengthening of the arc. We will suppose that a high resistance voltmeter, S, is placed across the ends of the lamp resistance, r_2, so as to include the arc and to take the place of the shunt coil. This voltmeter will indicate the pressure on the shunted portion of the circuit at any instant. Now, when the total resistance is $(r_1 + r_2)$, the current is c_1, and the volts on the shunt, S, will be equal to a, f; while, when the extra resistance is added to r_2, the current falls to c_2, and the pressure on the shunt rises to a, h, being increased by the amount, f, h. Clearly, then, f, h, gives the fluctuation due to the increase of the arc resistance; and it is this fluctuation which, for the slightest change of the arc resistance, will be required to bring the feed gear into action; so that we wish to make f, h, as large as possible for any given change of current in the lamp. A glance at the diagram will show that to do this we must bring the point, a, as far to the right as possible, making the fixed resistance included between the shunt terminals as small as we possibly can. To be quite clear about the matter we may work out the exact mathematical expression. The pressure on the shunt at any instant is

$$v = \frac{\mathrm{V}\, r_2}{r_1 + r_2}.$$

If we consider r_2 as a variable, the other quantities being constant, then

$$\frac{d\,v}{d\,r_2} = \frac{\mathrm{V}\, r_1}{(r_1 + r_2)^2} = \frac{\mathrm{V}\, r_1}{\mathrm{R}^2} = \frac{e\, r_1}{\mathrm{R}} = \text{a max.}$$

This represents the rate of change of volts on the pressure coil with respect to the change of the intercepted resistance, when there is a given pressure on the mains or when a given current is passing; and we desire to make this a maximum. The normal value of c, the current, is fixed by the design of the lamp; and if V is also fixed, it follows that the normal resistance $(r_1 + r_2)$ cannot be varied as we please, and that we can only make r_1 large by adding to it as much as possible of r_2. In other words, where the pressure of the mains is already fixed, and is too low to admit of sufficient steadying resistance being *added* to the circuit, the steadying power of the circuit may be improved by adding the main coil resistance, &c., to the auxiliary resistance which we are able to put into the circuit of the lamp. We should in such a case place the shunt terminals, *not* on the lamp terminals, but as close to the arc as possible. Theoretically, they should be placed at the carbon tips; but that is practically impossible in the ordinary construction of lamp. If they are directly attached to the carbon holders, the shunted resistance will include the variable resistance of the carbon rods, and some compensating device will be necessary in order to prevent a permanent accumulative change in the adjustment of the arc length. Such a compensating device is described in the chapter on lamp details.

If, however, we are at liberty to increase the main pressure, we may insert as much impedance into the circuit as we thing proper; and the more of it there is the better will be its steadying action. If the shunt now includes the total lamp resistance between its terminals, it is desirable to have an auxiliary impedance very much greater than this total lamp resistance; so that, even in this case, it will be profitable to place the shunt terminals as near to the arc as possible, thereby throwing most of the lamp resistance outside the shunted part. Incidentally, this consideration shows that two arc lamps will be steadier if placed in parallel across 100-volt mains, each with a choking coil absorbing some 55 volts, than if placed in series on these mains, with a small coil absorbing only 10 or 12 volts. Nor is the former method necessarily any less efficient than the latter; for choking coils do not absorb an amount of power which is equal to the apparent watts, but, owing to their low power-factor, or the large angle of lag of their self-induction, a very much smaller amount of power. There can be little doubt that, especially for street and open air lighting, with lamps in parallel run by alternating current, very much more satisfactory results will accrue from the provision of many rather than of few auxiliary volts. In every such lamp the results would be good, but in the open

air the sudden extra voltage which would be put on the arc directly any breath of cold air tended to extinguish it would be sufficient, where these volts were numerous, to prevent the arc from being blown out. Again, in the event of the arc being extinguished on account of friction in the regulating gear, there will be but little more stress on the shunt coil, if the auxiliary voltage is small; but there will be a very considerable increase of stress, sufficient to give a very heavy pull and to feed down the top carbon holder, if the reserve pressure is designed to be large. On the whole, the use of a heavy reserve of pressure is to be recommended in parallel arc lighting by alternating currents, and especially in street lighting; and this constitutes one of the chief points of recommendation of the parallel alternate current lamp. But it must be specially and carefully designed.

(To be continued.)

WIND MOTORS.

The utilisation of the wind for generating electricity has engaged the attention of more than one expert in electrical matters, notably Mr. Brush in America and Prof. Blyth in Scotland. The problem is a fascinating one, yet it is surprising how little attraction it has offered to our distinguished amateurs.

In considering the claims of the Rollason wind motor which we had the pleasure of examining at Willesden Junction on Tuesday last, we would like to dwell briefly on previous attempts at using wind power.

At the York meeting of the British Association, Lord Kelvin, then Sir William Thomson, suggested the construction of cheap windmills for electric lighting purposes. This suggestion followed on the introduction of the accumulator; it was not acted upon however till 1887, when Prof. Blyth erected an electric windmill in the village of Marykirk, Kincardineshire. This windmill was of the old English type, having four arms and canvas sails. This arrangement necessitated bevelled gearing at the top of a vertical shaft, and bevelled gearing at the bottom.

Although the original methods adopted by Prof. Blyth were crude, and the experiment was carried out on a smal scale, he seems to have been satisfied with the early results, for he afterwards devoted considerable time to improving his original form. The practical outcome of his investigations was a horizontal form of windmill, the theory of which was based on Robinson's anemometer, which consists of four hemispherical cups attached to four arms, moving in a horizontal plane about a vertical axis. The machine erected by Prof. Blyth in 1891 on this plan, consisted in replacing the cups of the anemometer by semi-cylindrical boxes attached to arms, each of which was fitted on to the vertical shaft. With this mill Prof. Blyth obtained highly successful results; it formed the subject of a paper to the British Association meeting held at Edinburgh in 1892. It might be interesting to give what Prof. Blyth considers from his experience to be the desiderata in a windmill for electric lighting purposes.

1. It must be always ready to go.
2. It must go without attendance for lengthened periods.
3. It must go through the wildest gale, and be able to take full advantage of it.

Before we pass on to consider how far the Rollason windmotor fulfils these eminently reasonable conditions we will refer to what Mr. Brush did in America.

Mr. Charles F. Brush's experiment was on a good deal larger scale and more costly than Prof. Blyth's attempt. He erected in his private grounds at Cleveland, a windmill which was capable of keeping charged cells sufficient to afford a constant supply to about 400 lamps. It this case a wheel 56 feet in diameter and provided with 144 blades was used. The wheel was fixed on a large horizontal shaft, from which countershafting was driven. There was a good deal of automatic arrangement about the construction, the position of the wheel was automatically controlled, and automatic switching devices were arranged so that the dynamo would go into effective action at 330 revolutions a minute, and an automatic regulator was provided which prevented an increase of E.M.F., no matter what the speed of the dynamo might be.

It will be seen from the foregoing that the experience of wind motors has been satisfactory, so far as the mere supply of electricity is concerned, but we think it should be pointed out that no data is yet available as to what is the initial cost of such undertakings, or of their maintenance.

The occasion of our visit on Tuesday was that of a Press view of the Rollason motor. After lunching at the Royal Oak Hotel, Harlesden, at the invitation of the directors of Rollason's Wind Motor Company, the party were driven to Willesden Junction, where the inspection took place. The wind motor is erected on a light iron structure about thirty feet high. It is claimed that such structures can be readily set up and taken down. It will be seen from the illustration that a horizontal design has been adopted. In

some respects the arangement is similar to that of Prof. Blyth. A vertical steel shaft running from the top to the bottom of the structure carries five concave sails which revolve on radius rollers immersed in oil. A number of inclined ridges or planes are fixed on the sails, and we are informed that the object of these is to deflect the force of the wind. Outside the sails is a framework or shield supported by cross arms bolted to a centre bearing which is free to rotate independently of the sails. On the top of the shield is a vertical shaft which carries a heavy vane, so that a change of wind has the effect of moving the shield into a position for protecting the convex side of the sails. The shield completely shelters two sails at one time, the wind exerting a force on the remaining three. The power developed by the motor is transmitted by the vertical shaft to a pulley, through gearing, the reduction being five to one, from whence the dynamo is driven by belting. A somewhat complicated mechanism is provided for disconnecting the dynamo from the shafting when the accumulators are fully charged; we hope to describe this minutely on some future occasion. The effect of this automatic arrangement is that after the accumulators are fully charged the belting from the overhead shafting would be thrown on to a loose pulley and the dynamo would cease to run, but as soon as discharge had taken place from the accumulators the belting would be switched over on to the dynamo pulley and the dynamo machine would proceed to charge the battery.

Governing is done from the vertical shaft, and excessive speed of the dynamo is, to some extent, also counterbalanced by automatically putting resistances into the circuit. It was unfortunate on Tuesday that there was very little wind, so anything like regular working of the motor was quite out of the question, but it was clearly established that the motor was quite capable of utilising exceedingly light breezes, whatever practical use these may be.

The total power which the motor can develop is 6 horse-power, which seems very small for such a large structure. 25 cells are in use at Willesden; these had been fully charged on the previous day, when a high wind had prevailed for a considerable time. Several large Sunbeam lamps, as well as sundry incandescents, were lighted on the occasion of the visit. It has been fully demonstrated that electric lighting by means of wind-motors was practicable enough under the requisite favourable conditions, and as the machine at Willesden is undoubtedly the largest of its kind that has yet been employed in England, the fact is interesting. Judging from what we witnessed, the motor should run with the minimum of attention, and, under certain circumstances, such a method of utilising a cheap power might be adopted with advantage.

It is often assumed, however, that when we have dispensed with coal bills we have reached the *ultima thule* of economical working. We grant that the dispensing with coal is something gained, but an important point to consider is the initial outlay necessary to provide such a form of motor, and its upkeep.

We do not wish to be accused of pessimism when we express fears that the use of such motors will be somewhat limited. True, if such a method were to give only a fair efficiency, a windmill might with advantage be used for the electric lighting of country mansions and other isolated places. The wind motor offers undoubted advantages as regards the small attention necessary, but whenever it is necessary it would need to be skilled. What we really need, now that wind motors seem to be practical machines, is some information as to cost; if it is moderate, and we see no reason why it should be otherwise, we may look forward to a moderate development of this means of obtaining electric power. But we must never forget that, like the sailing of small passenger vessels, it will be a question of wind and weather permitting.

CORRESPONDENCE.

The Heilmann Locomotive.

I have a good recollection of the accounts of Mr. Leonard's paper, and spent some time in trying to reduce three machines to two.

Theoretically, the method is almost perfect; it promises high efficiency, perfect ease of control, saving of power in stopping, &c., &c.

The difficulty is to find the generator.

It is easy enough to design a dynamo, which, at full excitation, will have practically no armature reaction, but I have never yet come across one which was capable of supplying its full working current at $\frac{1}{10}$th its normal voltage, without sparking badly.

It would be very interesting if Mr. Leonard would tell us whether he has found this difficulty, and, if so, how he has got over it.

Perhaps Mr. Sayers can help us out of the dilemna.

A. G. Seaman.

The Permanent Sample Exhibition for South Africa.

With reference to your remarks in the ELECTRICAL REVIEW of April 6th, anent the Commercial Sample Exhibition we are establishing at Johannesburg, unlike most exhibitions, this exhibition will *entirely* depend for its existence upon a satisfactory return to exhibitors in the shape of business done. We fully appreciate the position, and our efforts and influence will be used in every possible direction to bring about that end. One of the important points raised in your excellent article will receive our attention, and an efficient staff provided to deal with machinery (as well as other exhibits), as you suggest.

Hannan & Co.

April 12th, 1894.

Manganine.

Manganine may be regarded as non-magnetic as copper for practical purposes, but the filings are as magnetic as iron. This fact may not generally be known. It is possible, therefore, that very fine wire of manganine may possess magnetic properties, and should not be trusted without first testing.

David Salomons.

THE PACIFIC CABLE SCHEME.

In view of the Colonial Conference to be held in June at Ottawa, at which the scheme for a cable between Australia and Canada is to be considered, representations have been lately made to the Colonial Office. The advocates of the undertaking urge, says the *Times*, that the British Government should unite with the Governments of Australasia and Canada in guaranteeing the interest upon the capital required for a single line of cable. The Intercolonial Conference at Wellington considered that a guarantee of 4 per cent. upon a capital not exceeding £1,800,000 for 14 years would be sufficient to induce a company to undertake the construction of the line. But Mr. Sandford Fleming, the chief Canadian promoter of the scheme, thought that a joint guarantee of 3 per cent., representing a total charge of £52,350, would be sufficient, while the Colonial Conference thought £72,000 would be needed. Mr. Sandford Fleming suggests five routes, his object being to touch only at places where British influence is supreme. But the Wellington Conference proposed that the cable should touch at both the Sandwich Islands and Samoa.

In opposition to the scheme, important representations have been submitted to the Marquis of Ripon on behalf of the cable companies which control the existing lines between the United Kingdom and Australasia. They urge that the existing service was established solely by private enterprise, no Government subsidy, guarantee, or exclusive landing rights having been granted to the company. A cheap tariff was tried in 1891-92 and resulted in a loss of £55,000, borne equally by the guaranteeing Australian Governments and the company. For the second year the loss amounted to £43,500, when the Governments concerned were instrumental in raising the tariff from 4s. to 4s. 9d. on January 1st, 1893. The loss for the current year is estimated at £12,000. It is urged that as the present cable is duplicated throughout, and capable of carrying a far greater traffic than at present, an additional service is not wanted, and that the cost of £2,000,000 or £4,000,000 if duplicated, would end in ruinous competition. Moreover, if the Imperial Government joined in the proposed guarantee it could not in equity refuse to assist the existing service to the same extent. Any diversion of route would also inflict a heavy loss on the Indian Exchequer. The present traffic between Europe and Australasia consists roughly of 1,300,000 words per annum, and is worth about £209,000 a year. If the tariff was reduced to 3s. this amount would be reduced to £119,000, leaving a loss of £90,000. If half the traffic was diverted *viâ* the Pacific this loss would be increased to £150,000. On the other hand, a Pacific cable carrying half the existing traffic would, it is urged, only earn at a 3s. tariff about £45,000, after deducting outpayments. On the other hand, in order to meet its liabilities, it would have to earn £237,000, as shown in the following table :—

Capital		£1,800,000
Working expenses	£25,000	
Maintenance	35,000	
		£60,000
Amortisation to replace cable at end of 14 years' guarantee		105,000
Four per cent. interest on capital		72,000
		£237,000
Leaving, after deducting estimated earnings as above	£45,000	
And the proposed 4 per cent. guarantee...	72,000	
		117,000
A deficit of		£120,000

LEGAL.

W. Shelfer and Meux's Brewery Company *v.* City of London Electric Lighting Company.

Mr. Justice Kekewich sitting in the Chancery division of the High Court of Justice, commenced on Thursday, last week, the hearing of the consolidated actions brought by Mr. William Shelfer, the lessee, and Meux's Brewery Company, Limited, the owners of the Waterman's Arms, at Bankside, Southwark, against the City of London Electric Lighting Company, Limited, for annoyance caused to the tenant, and damage to the premises consequent on the defendants' working of electric generating machinery on land adjoining the plaintiffs' house, which till their purchase of it had been a ballast wharf; and asking for an injunction and £10,000 damages.

Mr. Warmington, Q.C., Mr. Badcock, and Mr. Waight were counsel for the plaintiffs; and the defendant company was represented by Mr. Fletcher Moulton, Q.C., Mr. Renshaw, Q.C., and Mr. Braithwaite.

The plaintiffs' case, as stated by Mr. Warmington, was that their premises are parallel with the Thames, and Shelfer holds them on a 21 years' lease, from March 25th, 1893, at a rent of £70 a year, he having paid a premium of £750 on entry. Until the acquisition by the defendants in 1891 of land at the back of premises parallel with plaintiffs, and divided from them by a shop of Sir W. A. Rose & Co., which defendants have also lately bought, this land had long been and had continued to be used as a ballast wharf. But defendants had erected generating sheds containing three engines, one of 1,000 horse-power, and two others of 500 horse-power each, and a shaft, from which at certain times a good deal of smoke was discharged, to return upon plaintiffs' premises, with large volumes of steam. The foundations of the shaft were about 30 feet from the street level, and those of the engine sheds were some 25 feet below that level. The vibration caused from the working of the engines had affected a leaning wall, and the noise was of a most irritating character, a constant whirr, whilst the vibration was so great that the beds fairly trembled in a way to be seen by the naked eye without being proved by touch.

In cross-examination by Mr. Moulton, Mr. Shelfer admitted that he occupied the premises a twelvemonth before he took the lease. Defendants during that time were working engines on the land, but they were further off than those of which he now complained. The steam and smoke, too, were at times very annoying.

Mr. Moulton said they were erecting machinery for condensing the steam and so getting rid of this complaint, but it would take some time.

His Lordship: I take it on Mr. Shelfer's own showing that small damages would meet that point.

Mr. Warmington: But I mean to question the legality of their carrying on these works.

Mrs. Shelfer, in corroborating her husband as to the nature of the vibrations experienced during the working of the machinery, said that beside shaking the bed, you could not sit in the house without being conscious of a shaking and vibration of the seat.

Mr. Thorpe, surgeon, of Southwark Bridge Road, said he attended Mrs. Shelfer in October or December for an irritable state of the nervous system, and when visiting her he noticed vibration in the house.

Miss Shelfer was also called and proved vibration, the effect upon her being giddiness when she got out of bed, and a feeling of sickness. It also extended to the windows and the glass in the house, and the noise downstairs could be heard very plainly.

Mr. Sewell, surveyor, put in and spoke to plans, and said he visited the premises in October last and found a humming noise, proceeding from the machinery, with pulsations. The windows rattled considerably, and at parts of the wall, on the ground floor, he could get his rule through the cracks made in it. On the second floor there were similar cracks, but wider; they extended the whole width of the wall, 8 inches. The ceiling was also cracked, and the roof and the party wall had parted company so that he could see daylight through it. These cracks he found, from a recent inspection, had increased and become more open, some of them being an inch and a-half or an inch and three-quarters wide. You could see the vibration of things in the rooms by the eye as well as by touch, varying in proportion to the number of machines running and their speed. If the cracks continue in the progress they have lately made, the rebuilding of plaintiffs' premises will be necessary.

Continuing the hearing of the case on Tuesday, Wednesday, and yesterday (Thursday), his Lordship heard the evidence of builders, surveyors, and frequenters of the house as to the noise they heard, the pulsations they experienced, and the cracks found in the upper walls extending downwards. To illustrate the character of the vibrations, one witness said several Garibaldi ladies' jackets were placed upright on one of the beds in the house, and they "shook like a jelly"; whilst a Thames lighterman, accustomed to use the house for some years, seemed to have been so astonished by the shaking of the doors and rattling of the windows, that, in his ignorance of the cause, he asked Mrs. Shelfer, "Be your 'ouse a 'aunted?"

For the defendant company, Mr. Renshaw called and examined Mr. David Cook, manager of the defendant company, who said they had expended on their scheme a total sum of about £800,000. Of this, their principal station, which was the one in question, with land and appliances, represented about £400,000. The company was under contract with the Commissioners of Sewers for the City of London to light the City, and already several of the principal streets were thus lighted, the obligations imposed on the company by their Act, including satisfying the Board of Trade and depositing £1,000, having been observed. The works generally, with the engines, dynamos, &c., were constructed on the newest and latest designs, and, as a rule, the engines and machinery worked smoothly and regularly, though occasionally faults would develop themselves, and then the engines would be shut down to rectify what might be wrong. At present the exhaust steam was discharged into the atmosphere by means of pipes leading through the roof, but there was in hand a scheme, which they hoped to complete by the end of June, to get rid of the exhaust and noise by large pipes running into, and half way across, the river. The site was selected as the most convenient and appropriate the company could find within their area. It was an engineering neighbourhood for a radius of a mile or more around the works, and it was busy and noisy. He had visited plaintiffs' house, and although no doubt the working of the machinery could be heard, he did not regard it as of a nature tending to the discomfort and inconvenience of the residents.

Cross-examined, he said he should not care to live there; indeed, he should not choose any part of the neighbourhood for his own residence. The plans of their works had been submitted to the County Council and the district surveyor. He acknowledged that isolation of the foundations of works of this kind had been recommended by various authorities on electrical works, and that this had not been done in defendants' case, though their works were the largest with which he was acquainted. They had some smaller works on the other side of the river, but they were gradually removing them to Bankside, and hoped to complete that removal by the end of the summer.

Mr. Chas. Thomson, architect to the defendants, and constructor of the works, said the excavation for the shaft was 31 feet below the engine house floor, and 27 feet below Bankside, and its nearest point to plaintiffs' house was 75 feet distant. The engines, on footings of concrete, wider than the walls, are entirely isolated from the main walls, except by the floor. He had inspected plaintiffs' premises, and found the cracks complained of in an upper bedroom, extending downwards, and pointed out by Mr. Shelfer. He regarded it as a very old crack, and he told Mr. Shelfer so, and he admitted that it had been there about 18 months or two years. The window frames were very loose, as is usual in old houses, and the windows rattled. Visiting the place subsequently, he saw but a little difference in the crack, but it seemed knocked about a little more. The defendants' engines and the steam could be heard in all the plaintiffs' rooms, except the bar. There was no more noise than you might expect in a neighbourhood covered with factories and works. Plaintiffs' was a very old house, had been built a long time, and cracks had developed in all parts of the front. The west wall proved, on plumbing, about an inch and a-half out of the perpendicular.

Mr. Frederick Henry Jackson, electrical engineer in charge of the electric lighting stations of the defendant company, corroborated the last witness as to the structural arrangement of the works, and, adding particulars as to the power of the engines, he explained that some of the complaints which had been made arose from their experimenting on the running and capacity of the engines at their start towards the end of last year. The newer engines, which are those nearest plaintiffs' premises, do not generally start work till half-past eight or nine in the morning, but pioneer machines, at the most distant part, work all night from about 9 p.m. On a particular day of complaint and visit of inspection on behalf of the plaintiffs, the load in the afternoon, as shown by the log book, was 300 amperes, and rose to 450. He visited plaintiffs' premises by arrangement, on one occasion, to try to ascertain what vibration there was, of which subject he knew something, while all the engines were working at full speed; but beyond hearing the windows rattle, and seeing the light things placed on the bed moving slightly, he could discover no vibration.

Cross-examined: He said the foundations of the engines stand on a bed of concrete, 3 feet 6 inches thick, but he was not sure whether or not it touched the wall, and so was completely isolated. There was an air space round it; but there was connection by means of the floor. Did not think it possible that the single engine ordinarily started about 8.30 a.m. would cause a vibration to be felt; if there were vibration, he should expect it to be felt later in the day. He suggested that the window rattling in the house was attributable to pulsations of the air caused by the steam coming from the engines.

Prof. Kennedy, one of the consulting engineers of the company, examined by Mr. Moulton, gave evidence relative to the construction of the defendants' works, and said upon a particular occasion, when they were running practically at full working, he could detect no vibration from them. Examining the Waterman's Arms' premises, he found in the wall in which the cracks occurred a drop of 3¼ inches in 26 feet; he also gave some details relative to declination in the premises (which defendants have bought) of Sir W. Rose between plaintiffs' and defendants' premises caused by settlement. He thought there was no vibration from the defendants' works which caused structural damage to the Waterman's Arms"; and on the occasion of his visit to plaintiffs' premises he found nothing to lead him to think the defendants' works caused annoyance or inconvenience to the residents.

Cross-examined: He said the foundations of defendants' buildings are many feet below those of the plaintiffs', and their excavations were 20 feet below Sir W. Rose's walls.

By the Judge: He did not believe that defendants' machinery, erected as they are, could structurally affect plaintiffs' premises, supposing them to be well built and in a fair state of repair.

Prof. Silvanus Thompson, next examined by Mr. Moulton, said he was one of the consulting engineers of the company, and was familiar with the Bankside works. The footing of the side walls was laid down a great deal (something like 10 feet) deeper than the footing of the engine beds, and separate beds of concrete were set up to carry the engines. These foundations were unusually massive, and the effect would be to lessen vibrations. He was consulted specially

in 1891 as to the type of engine to be constructed, and he thought that they selected the best. Six or seven thousand pounds had been expended in making preparations for the condensation of steam. He gave details of the number of ampères the engines give out, and to these added some measurements he had made of the cracks in plaintiffs' premises. In his opinion, the Garibaldi test was no test of vibration at all; nor did he agree with the suggestion that the neighbourhood generally is a quiet one. He did not regard defendants' works as likely to cause any structural damage to plaintiffs' premises.

Cross-examined: He thought the crack an old one, which had opened within the last two years, and widened within the last few months. The works were erected on water-bearing strata, and they were tapped by the excavations for defendants' buildings, the tendency of which would be to produce settlements.

Yesterday, Prof. Thomson was further cross-examined and evidence was called as to the structural condition of the plaintiffs' premises.

This concluded the evidence for the defence, and Mr. Renshaw addressed the Court.

After hearing counsel for the other side, his Lordship said he should order compensation to be paid to the tenant, and damages for structural injury to the landlords, the amounts to be referred for settlement to some competent persons.

Ebbsmith *v.* Dawson and others.

This action came before Lord Justice Coleridge and a jury, on Wednesday. The case arose out of certain matters in connection with the South Staffordshire Tramways Company and the Electric Construction Company. Sir Edward Clarke, Q.C., and Mr. G. Spencer Bower were for the plaintiff; and Mr. Murphy, Q.C., Mr. Blake Odgers, Q.C., and Mr. Hugh Fraser for the defendants.—Sir Edward Clarke, in opening the case, produced the circular containing the alleged libel, which in February, 1893, was issued by the defendants, who constituted the shareholders' committee of the Tramways Company, to their shareholders. This stated that whilst the shareholders in the South Staffordshire Tramways Company were being gradually educated to the idea of electric propulsion, and their authority obtained for the introduction of the necessary parliamentary measures, arrangements were being made in another quarter, apparently with the object of turning the profit to a good account, as on May 29th, 1889, a company was registered in London under the title of the Electric Construction Company, in which Mr. Joseph Smith (now Ebbsmith), the present plaintiff, appeared as managing director, with a holding of £4,260, as against £200 in the Tramways Company, and that his former partner, Mr. George Roseurs, was the registered owner of £20,000, as against two shares held in the South Staffordshire Tramways Company, and the chairman of the latter company, Mr. Carruthers Wain, was holder of £3,000, as against £500 in the Electric Company. The circular further stated:—"We find that Mr. Joseph Smith occupied the position of managing director until 1892, from the commencement of which his name ceased to be put forward in reports of the corporation, and it is curious to observe that Mr. Jabez Spencer Balfour and Mr. Henry Granville Wright, of Liberator notoriety, disappeared from the directorate at the time, and, for some reason or other, Mr. Smith changed his name at the end of 1892 by adding the prefix 'Ebb' to it; so that he is no longer Smith, but Ebbsmith." Sir Edward went on to say that the only conclusion which anybody could come to on reading the paragraph was that Mr. Smith, in using his earlier name as managing director of the Electric Construction Company, did so for the purpose of making money out of the South Staffordshire Company; and his interest in the Electric Company being so large, and his interest in the other so very small, he had made an arrangement for the benefit of the Electric Company. There was not the slightest foundation for the suggestions which had been made. Mr. Ebbsmith was called, and corroborated counsel, stating that he changed his name at the request of his maternal grandmother, who was named Ebb.

After hearing further evidence yesterday, Mr. Murphy interposed, and said that defendants desired him to say that they did not intend to convey that Mr. Ebbsmith's withdrawal from the company, or his change of name, had anything to do with the determination of Balfour's and Wright's connection with it, and expresed regret if the words used had led to that impression. He suggested that there should be a *stet processus*. The other side agreeing to this course, a *stet processus* was issued.

BUSINESS NOTICES, &c.

Ashton-under-Lyne and Electric Lighting.—A committee of the Town Council are of opinion that the question of electric lighting ought to be now considered. A special meeting of the General Purposes Committee is to be held to consider the matter.

Weston-Super-Mare and Electric Lighting.—The Electric Lighting Committee are arranging for the canvassing of different portions of the town, and for the issuing of a circular to each resident in such neighbourhood regarding the electric light.

Catalogues.—We have received a copy of the twenty-seventh edition (second issue), of "Steam, its Generation and Use." The book is really a catalogue of the Babcock & Wilcox boilers. It contains about 180 pages of well printed and interesting matter, interspersed with a large number of wood engravings and process blocks to illustrate the various chapters. There is much useful information for steam users in the book. The various sections deal with economy and safety in steam generation; the theory of steam making; theory of heating engines. Some of these and also a number of other chapters are abstracted from articles, lectures and papers delivered at various times before certain engineering and technical societies. The history of the Babcock and Wilcox boiler and the patents therefor are dealt with in detail. "Rules and Practical Data"; "Tests of the Babcock and Wilcox Boilers"; "Average Cost of Repairs" (from which latter it appears the repairs to these special boilers are infinitesimal in cost), are the titles of other chapters. About 36 pages are devoted to a list of some of the works, hotels, steamships, central electric lighting stations, gas works, electrical railways, mills, tramways, &c., in this country, on the continent of Europe, in America, and other parts of the world, which have been supplied with these now well-known boilers. The boilers at the Manchester Square station in London of the Metropolitan Electric Supply Company, the station of the Chelsea Electricity Supply Company, and the Deptford station of the London Electric Supply Corporation are among the various establishments described in this direction. Users of steam power will find much in the book of interest and instruction, and Messrs. Babcock & Wilcox offer to supply the book free to such on application. It is a production of the first class, bound in neat stiff covers. The printing of illustrations and matter, as well as the execution of the blocks, is excellent.

We have received from the General Electric Company, Limited, a copy of the new (10th) edition of their electric bell and general catalogue, which cancels all former issues, and comprises the following sub-sections:—Bells for house, stable, mining, signalling, fire alarm circuits—also various sets of bells. Holden's repeaters for electric bells have been re-modelled by the original inventor, who has placed them in the company's hands for introduction to the trade. Indicators have been lowered in price and new designs prepared. A large variety of designs of pushes in superior quality wood, brass, ormolu, and wrought iron, also table weights, &c., are illustrated. The company particularly wish to bring to their customers' notice the all china pushes. To anyone who has not seen these, they agree to send sample on application. Finding there was a growing demand for massive bell pulls, chiselled in antique and artistic styles, there have been prepared an extensive selection of new designs. A large amount of space in the catalogue is devoted to batteries, which are illustrated in all their different parts. E.C.C. dry cells, ventilating fans, driven by Edison-Lalande batteries, are described. Numbers of these fans have been sent to hot countries. Owing to the expiration of the incandescent lamp patents last November, reductions have been made in the prices of night lights. In addition to the usual form, a new type of gas lighter has been introduced, specially adapted for lighting gas stoves, also lighters with bent spires for window lights where inflammable articles are on show. Automatic gas-lighting apparatus, water level indicators, fire alarms, cables, clock alarms, testing and telegraphic instruments, lightning conductors, tools, &c., are fully illustrated and described. Estimates, diagrams, and instructions regarding the fitting of electric bells are added. The catalogue is very useful as a handbook on electric bell fitting in general.

From Messrs. Baxendale & Co. we have received a circular illustrating and describing the search-light apparatus in operation on the Manchester Ship Canal.

Messrs. W. Blenheim & Co., of Egham, have sent us one of their illustrated price lists of telephone instruments and accessories.

Electric Lighting at Notting Hill.—The Works Committee of the Kensington Vestry reported having had before them a letter from the Notting Hill Electric Lighting Company, applying for permission to lay a main in Uxbridge Road, in order that they may furnish a supply of electricity to houses in Melbury and Addison Roads, which streets are included in their area; also enquiring whether the Vestry would be prepared to recommend the Board of Trade to grant the company a license to supply electricity to houses in Uxbridge Road and Archer Street; and, the committee recommended that permission be granted to the company to lay a main in Uxbridge Road, but that they be informed that the Vestry cannot accede to their request as regards the supply of electricity to premises in Uxbridge Road and Archer Street, in consequence of these thoroughfares not being within the area of supply specified in the company's provisional order. The recommendation of the committee was agreed to by the Vestry.

Killarney Lighting.—A rather curious state of affairs exists at Killarney as regards the public lighting of that town. The streets there are now illuminated with both electricity and gas. The public lighting of the town has been for some time past a debatable subject at the Municipal Board. The majority of the town commissioners gave the contract for the lighting to the Killarney Electric Light Company, who have just now commenced operations for the lighting of the streets. The gas company, it is understood, will continue the gas light until the matter is settled in a court of law. If, in the end, the ratepayers will have to pay for the double lighting of the town, the commissioners will not have created a bed of roses for themselves.

Shirley and Freemantle Electric Lighting.—With regard to the question of electric lighting, the General Purposes Committee have decided to ascertain on what terms the old Washing Factory at Mousehole could be obtained for the purpose of erecting a central station.

The Electric Construction Company, Limited.—Mr. Blackburn, M.I.C.E., whose appointment we announced in a previous issue has entered upon his duties at Bushbury. As we announced last week, several changes have been made on the technical staff; the Board is confident that the new appointments made will lead to economy, and be in the interests of the company. Several large contracts have lately been secured, among them the electrical plant for Wolverhampton and Stafford. Instructions have been received from the County of London and Brush Provincial Electric Lighting Company to proceed with the plant for the lighting of the Clerkenwell district. The work for Halifax and Aberdeen is proceeding, and the company is also busy equipping the Madras electric tramways. An advance has taken place this week in the price of the ordinary shares from ¼ to ⅜ to ½ to 1.

Hooper's Telegraph and India-Rubber Works, Limited.—The estate of the late Mr. William Hooper has now been taken out of Chancery, and the Telegraph and India-rubber works will in future be carried on by Mr. John B. Hooper and Mr. Basil Gee, as managing directors of a limited company, for the purpose of continuing the business of manufacturers of India-rubber telegraph cable and general India-rubber goods, and extending the same for the supply of electric light, telephone, and other cables. The company being free from the disadvantages of working under the supervision of the Court, is now in a position to compete on equal terms with other manufacturers, and we feel sure that the managers will use their best endeavours to uphold the traditions of this old-established business, upon which we shall have more to say later as the result of personal experience. In the meantime we wish them the success they both so well deserve, and which everybody in the electrical trades will hope they may secure.

New Company.—Mr. Thos. Parker, who, as we announced last week, has recently severed his connection with the Electric Construction Corporation, is about to make a fresh start, and a new company for the purpose is soon to be registered. The works are to be in Wolverhampton, a fine site near the three railway stations having been secured. Mr. Parker's many achievements in electrical engineering are too well known to our readers to need recapitulation, and it is certain that his energy and his skill in the management of men will stand him in good stead in the conduct of the new business. Those gentlemen from the engineering staff of the E. C. Company, who left immediately before him, will also assist in the conduct of the new concern, and Wolverhampton will thus have an added stake in the electrical industry. Mr. Parker anticipates in a few months being able to undertake the largest contracts, and we sincerely trust that he may always command his fair share of electrical work offering.

Electric Lighting at Richmond.—The electric light at Richmond is being taken up freely on all sides, but the majority of the best work in the town has, it appears, been placed in the hands of Mr. C. A. Hemingway, and among the numerous installations which he has carried out may be mentioned Marshgate House for Alderman Robinson, J.P.; No. 5, Hill Street, for Wm. Burrell, Esq.; the Greyhound Hotel; the Castle Buffet; Nos. 6, 14, 23, 24, 27, 28, 50, 63, 78 to 81 George Street; several in Kew Road, &c. Owing to the rapid increase in business, Mr. Hemingway has already found it necessary to enlarge his premises, and, among other extensions, has added a showroom and workshops.

Buckingham and Electric Lighting.—At a special meeting held last week, a long discussion ensued as to the lighting of the street lamps. Since the last meeting of the Council, the secretary to the gas company had informed the Town Clerk, that, unless they were allowed to light all the street lamps with gas, they could not light any. The Council did not see how they could withdraw the contract with the electric light company under which ten lamps are now being lighted by electricity, and it was eventually resolved to invite the electric light company and the gas company to send in tenders for lighting the street lamps, excluding those already lighted by the former.

Tenders for Gas Engines.—The following tenders were received by the London County Council for the supply and erection of gas engines at the proposed new pumping station near Heathwall Dock, Nine Elms Lane:—

Crossley Bros.	£2,950
Dick, Kerr & Co.	3,045
Fielding & Platt	3,500
Tangyes, Limited	3,700
Robey & Co., Limited	4,153
J. E. Andrews & Co., Limited	4,165

Hartlepool Electric Tramways.—This subject was again before the West Hartlepool Town Council a few days ago, when it was reported that, as the result of an interview with the promoters of the scheme, it was decided to approve of the system terminating at the police station, the promoters to undertake to continue the trams into Church Street by the conduit system, if such a system should at any time be found to work satisfactorily; or, at the option of the committee, to run a double line down Church Street, with centre poles of an approved ornamental pattern, and to furnish an electric light to each post.

Electric Light at the Guildhall.—On the recommendation of the Coal and Corn and Finance Committee, the Commissioners last week ordered that the electric light at the Guildhall should be extended to the Art Gallery at an estimated cost of £290, inclusive of fittings.

St. Pancras Electric Lighting.—At a recent meeting of the Vestry, Mr. Sweet presented the accounts of the Electricity Committee for the past year. He said that there was every reason for the Vestry to be gratified with the financial result. The most interesting part was the revenue account, and though it showed a very small balance in hand, yet it was gratifying to know that they had covered the loss incurred on the first year's working. Up to December, 1893, the capital outlay was £96,085; the total income for the year was £15,021; repairs cost £96; insurance, £56; and all the working expenses of the undertaking, £6,212; so that supposing the Committee had determined to pay five per cent. interest—which would be a handsome interest after two years' working—involving £4,800, a balance of £1,412 would be left in hand, which could be set aside for depreciation and unexpected losses. This, he considered, was extremely satisfactory. There were some who said that the revenue had been made out of public lighting. The Committee, however, had been extremely straightforward, and had charged the Vestry 6d. per unit for the current supplied—the same as private consumers were charged—and they had measured the current at the station, and not at the lamp-posts, though there was a certain amount of loss in transmission. £13,000 had been spent on public lighting. Certain economies would be introduced, such as the alternative lighting of the lamps at certain times. He considered that the Vestry should be satisfied with the results of the undertaking.

Electric Lighting at Manchester.—Messrs. Baxendale and Co. have lately secured the following contracts for lighting work in Manchester:—Arc and incandescent lighting at Messrs. Hepworth's shops, Market Street; incandescent lighting at Mr. Hedley's, Fountain Street; additional arc lighting at Messrs Scarfpia & Co., Oldham Street; also incandescent lighting at Messrs. Hall & Co., Oldham. The same firm have also fitted up telephonic communication with the fire station at Chorley Workhouse, Chorley, and a telephonic installation at Messrs. Booth & Co.'s establishment, Hall Street, Manchester.

The Singapore and Hong Kong Cable.—The Eastern Extension, Australasia, and China Telegraph Company, Limited, state that the laying of the first section of their alternative cable between Singapore and Hong Kong—namely, between Singapore and Labuan—is now completed, and open for traffic. In addition to affording direct telegraphic communication with Labuan, this line practically brings British North Borneo into telegraphic communication with the rest of the world. The tariff from Great Britain to Labuan is 6s. 5d. per word.

Business Alteration.—Mr. J. T. Bolding, of Grosvenor Works, Davies Street, W., informs us that he has registered his business as a private limited company. His only reason for making this change is to improve the position of the manager and staff, and give them a pecuniary interest in the business. The business will be conducted as hitherto under Mr. Bolding's personal superintendence and management. No shares will be offered to the public, all the shares being held by Mr. Bolding and the employés. The business will be carried on under the name of John Bolding & Sons.

Appointments.—The Electric Lighting Committee of the Bedford Town Council have appointed Mr. Medhurst their electrical engineer with instructions to prepare plans and estimates for lighting the High Street and shops, with provision on a sufficient scale to allow for extensions. Both public and private lighting are to be undertaken.

Lieut. A. H. Dumaresq has been appointed assistant instructor in electricity at the Chatham School of Military Engineering, vice Captain A. M. Stuart, who has vacated that appointment.

Proposed Tramway from Clontarf to Howth.—Last week a Board of Works inspector held an inquiry at Howth into the proposed scheme for the construction of a tramway from Clontarf to the summit of the hill of Howth. A company has been registered to carry out the project under the title of the Clontarf and Hill of Howth Tramway Company, Limited. The scheme is opposed by the Great Northern Railway Company. Mr. S. G. Fraser is the promoters' engineer.

Bolton Electric Lighting.—At the last meeting of the Electricity Sub-committee of the Bolton Corporation, a letter was read from Messrs Siemens Bros., Limited, making proposals for the substitution of their new type of high-tension armour cable in place of the cables originally contracted for. The proposal was agreed to, subject to the testing of the cables proving satisfactory to the engineer and chairman. Messrs. Siemens will start laying the cables before the end of this month.

Ayr Electric Lighting.—At a recent meeting of the Town Council the surveyor submitted a report on the electric lighting of the town, which was favourably received by the Council, and the Town Clerk was instructed to communicate with Mr. Robert Hammond and ascertain if he would undertake to make a survey and report on the subject with a view to the immediate introduction of the light.

Electric Lighting at Bootle.—The Bootle Town Council has decided to light by electricity all the Corporation buildings, including the Town Hall, and offices, library and museum, police court and station, and baths. Tenders for the work will be submitted to the next meeting of the Council. Application is being made to the Local Government Board for sanction to borrow £3,600 to carry out the works.

St. James's and Pall Mall Electric Light Company.—The electric current sold for the quarter ended March 25th, amounted to £10,375, as against £10,119 in the corresponding period of 1893.

Mill Lighting.—Mr. Thomas Barton, of Blackburn, has completed the electric lighting of the paper mills belonging to Messrs. D. & S. Ockleston, Mill Bank Mills, Irlam, near Manchester. The plant comprises one Barton's "Electric" dynamo, capacity 16 kilowatts at 800 revolutions per minute, driven by a vertical engine running at a speed of 200 revolutions per minute. The installation work is carried on upon Barton's system in those parts of the mill where chlorine and a damp atmosphere are present, this being the 24th installation which has already been carried out in this country and India upon this system, wood casing having proved a productive source of faults under the conditions which exist in most paper mills. Messrs. D. & S. Ockleston expressed themselves highly pleased with the working of the plant which has been in continuous operation since March 31st.

Fareham Electric Lighting.—The Fareham Electric Light Company have offered their business, with all buildings, plant, machinery, mains, meters, &c., together with their provisional order, to the town, either at the cost price of the same, as standing in the books of the company, or by valuation. The proposal is to be considered at a public meeting of the inhabitants on the 26th inst.

Shrewsbury Electric Lighting.—The Shropshire Electric Light and Power Company have placed in the hands of Messrs. Edmundson & Co., the work of supplying and erecting electric lighting plant and apparatus for the supply of electric light to the town of Shrewsbury, including buildings, engines, dynamos, mains, cables, &c.

Basingstoke and Electric Lighting.—The Public Lighting Committee have been empowered to employ the services of an electrical engineer to report on the probable cost of an installation for the public lighting of the borough, at a fee not exceeding twenty guineas.

Electric Lighting of Derry.—The Local Government Board has agreed to grant to the Derry Corporation a further loan of £2,870 18s. 7d. in the excess of the original loan so as to enable the Corporation to complete the original scheme for the erection of 160 arc lamps.

CONTRACTS OPEN.

Brighton.—April 30th. The Borough Council invite tenders from such persons as may be willing to enter into a contract for the supply and erection of Willans engines, continuous current dynamos, pipework, spare armatures, &c. Specifications can be obtained on application to the Town Clerk, at the Town Hall, Brighton.

London, S.E.—Tenders wanted for travelling jib land crane, also dynamo and lighting installation. Apply C. H. Glover and Co., Hatcham Saw Mills, Ormside Street, Old Kent Road, S.E.

Southampton.—May 8th. The Harbour Board are prepared to receive tenders for work comprised in the electric lighting of the Town Quay, Southampton. Plans may be seen, and specifications and forms of tender obtained at the offices of the engineer, Mr. J. G. W. Aldridge, A.M.Inst.C.E., 9, Victoria Street, London, S.W., and 23, High Street, Southampton.

Spain.—May 5th. Tenders are invited by the Municipal Authorities of Caceres, Spain, for the electric lighting of the town. Caceres is a town in Estremadurada, with a population of about 10,000.

BOOKS RECEIVED.

Electrical Apparatus for Amateurs, in five parts, by various authors. Edited by Francis Chilton-Young. Published by Ward, Lock and Bowden, Limited, Warwick House, Salisbury Square, E.C. Price 1s.

Journal of the Institution of Electrical Engineers, No. 110, Vol. xxiii., April, 1894. Published by E. & F. N. Spon, 125, Strand, W.C. Price 3s. 6d.

FORTHCOMING EVENTS.

Tuesday, April 24th.—Royal Institution, at 3.0 o'clock. Lecture on "Electrical Illumination," by Prof. Fleming.

Thursday, April 26th.—The Institution of Electrical Engineers. Ordinary general meeting at 8 p.m. Meeting at the Institution of Civil Engineers, 25, Great George Street, Westminster, S.W., paper on "Cost of Electrical Energy," by R. E. Crompton, M.Inst.C.E., Vice-President.

NOTES.

The Action of Electrolysis on Organic Substances.—Hitherto we have chiefly heard of electrolysis in connection with the inorganic compounds, but the process appears to be of much wider application, and it is not too much to expect that in the near future organic substances will be manufactured or decomposed as desired, on a commercial scale. The following are some examples of recent work in this direction:—*Reduction of Nitro-benzene.*—This was first accomplished by Gattermann and Koppert, but has been perfected as a process quite recently by Haeussermann (*vide Chemiker Zeitung*, xvii., pp. 129 and 209). Nitro-benzene (25 grammes) dissolved in alcohol (350 cc.) and mixed with a solution of sodium hydroxide (40 grammes) in water (50 cc.), is introduced into a porous cell which contains the cathode (iron or platinum, according to the nature of the solution). The porous cell stands in an outer vessel containing a platinum or carbon anode, and filled with dilute sodium hydroxide. A current of 6—8 ampères, at a potential of 6 volts, is used. Precipitation on the surface of the cathode at once commences, and at the end of 10 hours benzidene is obtained, the reduction being then complete. If the reduction is performed in acid solution, the quantities are arranged thus:—Nitro-benzene (25 grammes), sulphuric acid (30 grammes), water (100 cc.), and alcohol (350 cc.), are placed in the porous cell. A current of 5 ampères at a potential of 4·5 volts is used, and the cathode again receives the precipitated matter, which, in this case, is benzidene sulphate. *Production of Aniline.*—This invaluable dye stuff is produced in small quantity if the above solutions are heated, before electrolysis begins, to 60°. It is doubtful, however, whether it could be made commercially in this way, since a large proportion of the nitro-benzene remains unaltered. Further research might elucidate the question. *Oxidation of Glycerine.*—Glycerine possesses a high resistance; it is therefore necessary to dissolve various inorganic substances in it in order to lessen the resistance. Under these circumstances, and using dilute sulphuric acid or sodium nitrate (0·1 per cent.), the glycerine is oxidised when a very weak current is passed into it. For details, consult a paper by W. E. Stone and H. N. McCoy in the American *Chemical Journal*, xv., pp. 656—660. *Reduction of Aromatic Nitro-compounds.*—By reducing paranitrotoxelene, using electrolysis as the chief adjunct, paratolyl hydro-oxylamine is obtained, according to K. Koppert and L. Gattermann. Other substances, hitherto only obtainable by purely chemical processes, have been manufactured recently by them from other aromatic nitrogen compounds.

The Clark Standard Cell.—Two papers in the *Annalen der Physik und Chemie* on the Clark standard cell deserve really more notice than we have space to give the subject. In [2] li., pp. 203—211, K. Kahle gives minute instructions for the preparation of this cell in the H form devised by Lord Rayleigh, which he finds to be the most suitable. The principal points regarded as requiring the most attention are that the positive mercury electrode be as pure as possible; that the whole of the active electrodal surface be kept in contact with the zinc sulphate solution; that this solution be always maintained in a concentrated state by the presence of zinc-sulphate crystals; and that the zinc-sulphate be acid free. At page 174 in the same number of the *Annalen* Kahle describes a number of experiments undertaken with the above form of cell with the object of determining the effects which change of form, purity of material, age, and temperature have on its electromotive force. He finds that the variation of the E.M.F. of this form of cell can, by attention to detail, be reduced to 0·0001 volt. This H type was compared with the Feussner "Clark" and that adopted by the Board of Trade, and greatly to the advantage of the first-named. Kahle considers that the temperature co-efficient of the latter two are usually misleading, and that the E.M.Fs. calculated by means of them are erroneous. The H cell can be calculated for different temperatures to within 0·0001 volt, and even with sudden changes of temperature to within 0·001 volt. The co-efficient for temperatures between 10° and 30° C. was found to be $-0{\cdot}000514-0{\cdot}000007\ (t-15)$. Kahle criticises the Board of Trade standard cell severely, and urges its replacement by the H form of Clark.

Lectures.—On Monday evening, at the Central School, Sheffield, Mr. T. Scott Anderson gave the second of the course of lectures on "The Generation and Application of Electric Currents."

Accumulators without Lead: a Novelty from Austria.—An accumulator, in which neither lead nor lead oxides play any part primarily as materials, has recently been devised by Sigmund Randnitz. There is a paper on it by K. Leur in the *Mitth. K. K. Tech. Gwoesbe-Museums in Wien* (1894, pp. 84—89); but the author omits to explain exactly how the apparatus is formed. Indeed, it appears that some compound is used, the nature of which is kept secret. This is the weakest part about the invention, and will not appeal to English electricians, who like everything "fair and square, and above-board," and, if a thing possesses real merit, are prepared to pay handsomely, in the way of royalties for using it. As far as we can gather, the secret compound is charged into the plates and becomes converted into a stone-like peroxide without buckling or altering in shape. A cell of three plates (one +, two −), weighs 1·09 kilos. (each plate having a surface of 6 × 16·5 cm.), and has a capacity of 32·8 ampère-hours, or 30·1 per kilo. Compared with the capacity of other well-known types, the Randnitz accumulator appears to stand extravagantly well, as is seen from the following figures:—Planté, 3—4 capacity; Faure, 10—15 capacity; Tommasi, 22·5 capacity; Tudor, 3·5—4 capacity; Randnitz, 30·1 capacity.

Smoke Absorption.—We are in receipt of a report upon Col. Dulier's system of smoke absorption as at present applied at the City Saw Mills, Glasgow. The system consists essentially of a steam jet or jets to assist the draught and dampen the dust, and of a fine water spray to precipitate the dust and soot and absorb the sulphurous acid. Mr. Tatlock, the public analyst of Glasgow, is responsible for the figures given. He records no diminution of draught by the water gauge when the apparatus is at work, and his tests show an almost entire disappearance from the escaping gases of dust and soot, and a reduction of sulphurous acid to one-half. Altogether the report is a quietly worded and modest production, and it is quite pleasant to find that only half the sulphurous acid was removed. So many experts would have proved the conversion of the acid into caustic soda. It would appear that from about 3 tons of coal and half-a-ton of wood waste per day burned in a smoky water tube boiler about 30 lbs. daily of sulphurous acid would escape to the atmosphere. This is reduced to 14 lbs. About 100 lbs. of soot is reduced to 6 lbs. From a continuously smoky chimney 100 lbs. of soot is only about 1½ per cent. of the fuel, showing how little real saving there is in abolishing soot, though it is so desirable to do so. The diminution of the sulphurous acid is not so marked as might be wished. Probably a longer traverse of the water spray would produce better results. The water can be used over again until too much saturated with acid, and the filtered out residue can be burned. We are much inclined to think favourably of the cleansing of smoke. There is nothing gained by the perfect combustion of coal in refractory furnaces so far as regards the elimination of the sulphurous products which are in a moist climate the worst in their effects on buildings and on the eyes and lungs. Tested by Messrs. Cross and Bevan, with a kitchen fire in London, about half the sulphur was taken out when the atmospheric temperature was 50°, lower temperatures giving better results. About 10 gallons per hour of water was used when burning 20 lbs. of coal. Without means to use the water over again, this will be a difficulty in the way of applying the system to house fires, but in a works the water can be pumped round and round, and only the loss by absorption need be made up. Better results are hoped for by improvements in the apparatus and flues. So far as we can see there is nothing impossible or improbable in the figures and claims made in this report, and we shall be glad to hear of the result of future trials. To abolish the sulphurous acid would indeed be a great achievement, despite the claim made for it that it is so powerful a disinfectant. No doubt it is—it probably destroys microbes; but men are but microbes of a larger growth to all the sulphur acids.

Bradford Electric Lighting.—A Sub-committee of the Town Council has been appointed to deal with the smoke nuisance at the electricity works. A Sub-committee has also been appointed to look into the question of lighting at Heaton, Allerton, Thornbury and Tyersal.

Central London Railway.—The Standing Orders Committee of the House of Lords last Monday decided to dispense with the Standing Orders not complied with in the case of the Bill promoted by the Central London Railway Company for an extension of time until 1900 within which to construct that railway. A similar decision has already been given by the Standing Orders Committee of the House of Commons. The Bill will now proceed in the usual manner.

Electric Lighting of Mills in Providence, U.S.A.—The extensive mills of the National and Providence Worsted Mills Company, Providence, R.I., U.S.A., are lighted entirely by electricity, with the exception of a few gas jets which are used when the mills are shut down. These mills are six in number, and cover an area of 10 acres, and there are 2,500 people engaged. The electric lighting is divided into two different plants. Three of the mills are lighted by arc lamps of 1,200, 1,600, and 2,000 C.P. each. The other three mills are lighted by 1,300 16-C.P. incandescent lamps in certain rooms, the remainder of the rooms being lighted by 1,200 C.P. arc lamps. The total number of arc lamps is 567, and incandescent lamps 1,300. To supply current to these lamps there are 19 dynamos, 14 of which are of the Ball arc light system of New York, one of the Mather arc system, two Mather incandescent system, and two Edison dynamos. The chief electrician (Mr. Herbert Buck) is an Englishman, and has had charge of the plant of the National Mill for four years, during which time he has never yet had to shut down the lights for any cause whatever when the mill was running. On one of the weaving rooms, which is 280 feet by 100 feet, there are 87 arc lamps of 1,200 C.P. each. It is considered to be one of the best lighted weaving rooms in the United States. Throughout the whole of Providence there is hardly a mill which is not lighted by electricity. It seems that it will be a long time ere that will be said of English mills, although of late there have been quite a number introducing the electric light into their premises. The machinery at the mills in Providence, to which we have referred, has been running nine years, and gives just as good a light to-day as when laid down.

Waste Energy.—The above title is apt to lead one to expect some remarks on tidal motors. Instead, the author of the paper with this title in the April number of *Cassier's Magazine* is sorely exercised at the large amount of power consumed, as measured by the coal used, and the very small amount of net work done. He endeavours to fix ideas by taking an office building of the American type; would we had a few of them in London. The American office building is the one item in America wherein Americans might safely claim absolute pre-eminence, and it is the one item they never do brag about. Taking account of the elevators, he points out that theoretically there is no power required, for those who ascend also descend, and so do the cages. To heat the building of 15 floors, 50 feet by 100 feet, would require 85 tons annually; to light it would require ·044 ton for an assumed million lamp hours. But he finds that actually some 290 tons will be used, and he assumes about 580 tons more to be wasted in mining, &c., to get the 290 tons into the building, so arriving at a total of nearly 870 tons to do the work of 85·044 tons. We think he exaggerates the loss in mining, &c. His remedy would be electricity to heat the building, electric motors to displace the hydraulic gear of the elevators, and so on, but he entirely overlooks the fact that much of the waste is due to our ideas of luxury or safety. A man engine as used in mines would be infinitely cheaper to work than the Otis elevator, and would secure the benefit of the gravity of the descending users. The cage elevator is a safer and easier arrangement, but involves weight and friction, which all require power, and will equally require power when the problem has been solved of obtaining electric energy direct from coal, or better still, from that ether which the professors tell us hovers in jelly form in the interstellar space and elsewhere.

The Royal Society.—The following papers were down for reading before this Society yesterday afternoon :—Prof. Hartley, F.R.S., "On Variations observed in the Spectra of Carbon Electrodes, and on the Influence of one substance on the Spectrum of Another." E. H. Barton, "Electrical Interference Phenomena, somewhat analogous to Newton's Rings, but exhibited by Waves along Wires." G. F. Emery, "Thermoelectric Properties of Salt Solutions."

Indian Telegraphs.—In the House of Commons last Monday, in answer to Colonel Howard Vincent, Mr. H. Fowler said : "Competition for the supply of telegraph material for the Indian Telegraph Department and other branches of the India Office is not restricted to specially favoured houses. Any British or Irish firm that can satisfy the Department of its ability to supply goods of the quality required will be placed on the India Office list of contractors, and will be invited to tender as opportunity offers. Experience has shown that it is not advisable to purchase stores of this description by public advertisement."

The Newcastle Institution of Civil Engineers.—At a meeting of the Newcastle Association, held at the Durham College of Science on Wednesday evening, the 11th inst., Mr. Thomas Hanning, A.M.Inst.C.E., delivered a paper upon "Electrical Motors," in which the author referred to the importance and increasing adaptation of electricity to do mechanical work, and its close associationship to civil and mechanical engineering ; discussing fully the modes of generating electricity, the construction of different generators and motors, and those best adapted for doing certain work ; the favourable efficiency of electricity as compared to other systems used for the distribution of power ; illustrating and describing pumping, coal cutting and haulage plants for mines, and concluding with a complete plant which might be used by contractors in constructing a dock, and afterwards used for working the permanent machinery, such as gate machines, sluices, pumps, capstans and cranes, and this entirely by electric power motors. The paper was illustrated by lantern slides.

Electric Illumination. — In his third lecture on "Electric Illumination," at the Royal Institution on Tuesday, Prof. J. A. Fleming began by describing the effects of age upon the light-giving qualities of incandescent electric lamps. He stated that, in general terms, a rise of resistance and decrease of candle-power were the results of changes taking place in the filament. Passing to the subject of arc lighting, he mentioned there were three modes of electric discharge—the glow discharge, the spark discharge, and the arc discharge. The two former modes pass spontaneously into the arc discharge if the pressure and quantity of electricity are great enough. The formation of an arc between carbon rods was then shown, and it was experimentally proved that the arc could not be started unless either the rods were first brought into contact or the insulating power of the air between broken down by an electric spark. An immensely magnified image of the arc was projected on the screen, so that its interior structure was rendered visible. It was seen, for instance, that the positive carbon rod becomes most intensely hot at the extremity, and hollowed out into the form of a crater, from which about 80 per cent. of the total light is emitted. The negative carbon does not become so hot. The space between the two, or the true arc, is filled with vapour of carbon. In the central space a brilliant violet axis is seen, violet being the colour of incandescent carbon. Outside this is an aureole of carbon vapour of yellow or golden colour. With the use of a prism the central axis of the arc gave a spectrum marked by two brilliant violet bands. It was next shown that the rise of electric pressure in the arc takes place chiefly at the surface of the crater, which is, in fact, the place where the work is done in evaporating the carbon. The light emitted is, therefore, due chiefly to the incandescence of the carbon in the crater. Hence the light is not given off equally in every direction. It is most intense in that direction in which the largest area of crater can be seen. The subject of arc-lamp mechanism was then lightly touched upon, and a number of varieties of arc lamps exhibited in action. In conclusion, the lighting of streets by arc lamps was shortly discussed.

Montrose and Electric Lighting.—A deputation has visited several towns and inspected the electric lighting stations, with the result that they recommend for Montrose a similar station to that recently opened at Coatbridge. Before deciding the matter, the whole of the board intend visiting Coatbridge.

National Association of Colliery Managers.—Last Monday the members of the South Staffordshire branch of this Association made an inspection of the South Staffordshire Tramway Company's generating station at James Bridge, being received by the general manager, Mr. A. Dickinson. Afterwards, at the Stork Hotel, Walsall, a meeting was held, when Mr. F. Brown (of the Walsall Electrical Company) read a paper on "The Lighting of Mines by Electricity." A brief discussion followed, and the annual dinner was afterwards held.

Electrolytic Thermo-Electric Cells.—In the *Annalen der Physik und Chemie* ([2], l, 696), there is an interesting paper by A. Gockel, in which is described an investigation of the electromotive force of thermo-elements, constructed on the following plan :—

Cold	...	...	Mercury | solid mercury salt.
Neutral	...	...	Salt solution.
Hot	...	...	Solid mercury salt | mercury.

In general it was observed that the thermo-electric force for 1° difference of temperature increases with dilution of the solution. It is practically the same in equivalent dilute solutions of similar salts of an acid. The investigation confirmed Ebeling's observation, namely, that the worst conductors are the most active thermo-electrically ; and that some show a maximum thermo-electric force at the concentration of maximum conductivity.

The Velocity of Ions.—This obscure yet fascinating subject has chiefly been identified with Hittorf, who has succeeded in throwing a good deal of light upon it. Others have approached it with more or less success, but the information existing needed judicial classification. This has now been done by F. Kohlrausch, than whom none is better qualified to give each determination its due weight. In the *Annalen der Physik und Chemie* (ii., l., pp. 385—408) he has collected and discussed all the available data bearing upon the speed of electrolytic ions, the numerical tables being arranged, as far as possible, to show a comparison. Hittorf's table of numbers for the anion of 28 electrolytes at different solutions occupy the most prominent place. Kohlrausch shows that the speed of the chlorine ion (we select this on account of its commercial interest) is the same in solutions of the alkali chlorides at equivalent concentrations from semi-normal downwards, and that the speeds of the two ions in these and similar salts are *additive* in dilute solutions. As a first approximation, he considers that the increase of the molecular conductivity for the same amount of dilution of different salts is the same.

Institution of Mechanical Engineers.—The anniversary dinner of the Institution of Mechanical Engineers was held on Wednesday evening at the Freemasons' Tavern, Great Queen Street, Prof. Alex. B. W. Kennedy, the president, in the chair. After the loyal toasts had been duly honoured, the chairman proposed "Scientific and Professional Societies," to which Lord Kelvin and Dr. J. Russell Reynolds replied. Sir Douglas Galton gave the toast of "The Bench and the Bar," and Mr. Justice Romer, as leader, with Sir R. Webster as his junior, were both racy and humorous in their replies. Mr. J. Hartley Wicksteed submitted "Our Guests," which was acknowledged by Canon Ainger and Sir Salter Pyne. Lord Reay, in proposing "The Institution of Mechanical Engineers," said a great demand existed everywhere for a knowledge in mechanical engineering, and the profession had a great future. The belt of polytechnics all round the country proved the demand there was for this useful knowledge, and in the solution of the scientific problems of the future he believed this Institution would be rightly placed in the advance guard. The chairman, in reply, expressed the pleasure he felt that the scientific part of their profession now formed part of the curriculum of our great universities.

Burton and Electric Lighting.—The new municipal buildings are to be lighted by electricity at a cost of about £997 13s.

Lancaster Electric Lighting.—The Corporation commenced a continuous supply of current on Tuesday, April 17th.

Buxton and Electric Lighting.—The Local Board are to hold a special meeting to consider the question of electric lighting the town.

Livet Destructor.—Just as we go to press a letter has arrived from Mr. G. F. Priestly, replying to our last week's leader. We regret we are compelled to hold the letter over until next week.

Glasgow and West of Scotland Technical College.—On the invitation of Prof. Jamieson, a reunion of friends and former students was held last Friday at Bath Street, Glasgow.

Electric Lighting in Manchester.—A large number of the members of the Gas Committee met last week at the electric light station in Dickinson Street to witness the unveiling of a tablet recording the opening of the works.

Fire.—A fire broke out on Wednesday, last week, at the works of the Fowler-Waring Cable Company, Henley Road, North Woolwich. A building of one floor, 100 feet by 15 feet in dimensions, was destroyed, and much damage was done to a larger building of two floors.

Electric Metres.—Our American namesake has gone further than Silas Wegg; it has actually dropped into poetry. The occasion of the dropping is the recent meeting of the National Electric Light Association. We have no fault with it except that the metre is electric, and therefore wrong.

Provisional Orders.—The Board of Trade has made orders under the Electric Lighting Acts, relating to Barrow-in-Furness, Buxton, Chipping Wycombe, Chesterfield, St. Helens, West Hartlepool, Grimsby, Harrow, Leyton, Monmouth, Peterborough, and St. Austell, and Bills to confirm them have been just laid before the House of Commons.

A Strange Communication.—Sir David Salomons writes us that he has received many strange letters in his time, but none equal to the one, from Australia, from which we make the following extracts:—

Dear Sir,—In the event of their being anything original in my exsperience and Ideas that may be instrumential to lead to discoverys of Commercial Value, would you kindly see to reserve me a share or interess, as the severe drought has made me poor, and I have a large Familie to maintain. I belive we are in table wrapping only Toy playing with one of the greatest most powerful forces of nature seemingly Tousend times more powerful and Electricity as we at present knows it, and what main in perfect subjugation as slave to the human mind and hand at will effect its powers seemes perfectly unlimmited to me. In the first *seance* I ever hade with two most respectable Gentelmen the table rose with a pressure of a ½ Ton without the slightest Vibration or any signe of the limmits of its power that we where convinced that if it been 50 tons it would have rose all the same. . . . . I only wish to convince science that communication without wires with this world and Invinsible universial intelligence in space lays' in Animal Electrical Currants and leave it for you that have means to investigate and discover; Either the Medium and the possitive creats the currants, but I am more inclined to belive that some analythical part or substances of the Medium and Possitive attracts the currant which the spirritual communications brings with it. Now my humble Idea in proceeding to discover those currants would by slightly charging any ordinary *Medium* with a Galvanic Battery and slightly adding or mixing the different analythical part of the human body to the Battery till we discover what substance increases the mediums power; praps Hydrogen or Oxygen may be the force of strength of the currant. I have hade the table wrapping till I could not distinguish it from listening to click of a telegraph office only less metallic in sound, nearly all Invincible Intelligence seemes delighted to communicate by of Currants of Thought reading, pressentiment and Clair vayence &c. I belive this Currant of Animal Magnetism is equal as if not more universial used as the Telegraph System of the Universe by established immutable laws, and worked in similiar manner as the Currant allready discovered by Battery, being related to them as universial Currants.

NEW COMPANIES REGISTERED.

South Devonshire Gas Light and Coke Company, Limited (40,928).—This company was registered on the 13th inst. with a capital of £10,000, in £1 shares, to enter into an agreement with F. V. Thomas to manufacture, sell and supply gas and electricity in the United Kingdom and elsewhere, and to carry on the business of a gas works and electric lighting company in all its branches. The subscribers (with 1 share each) are: R. B. Fastnedge, 2, East India Avenue, E.C., merchant; W. B. Macwhinnie, 53, Queen Victoria Street, E.C., actuary; J. W. Lance, 77, Palmerston Buildings, E.C., insurance broker; S. Toppin, 27, Clement's Lane, E.C., solicitor; G. D. Griffiths, 13, Leighton Lane, Tulse Hill, engineer; M. Ehrenfeldt, 9, South Place, E.C., accountant; J. O'Neill, 317, King's Road, S.W., agent. The number of directors is not to be less than three nor more than 10. Qualification, £50. Remuneration to be fixed in general meeting. Registered by Winter & Co., 16, Bedford Row, W.C.

International Electric Storage Company, Limited (40,850).—This company was registered on the 4th inst. with a capital of £200,000, in £5 shares, to purchase all or any part of the shares, works, undertakings, business, property, and liabilities in and of the Universal Electric Lighting Company, Limited, to acquire all the letters patent of Messrs. Theryc and Oblasser for electric accumulators, to acquire any invention likely to be of use to the company, and to carry on the business of electricians and all analogous trades. The subscribers (with 1 share each) are: *S. Flood Page, 102, St. George's Square, S.W., major; *J. L. Higgs, 43, Finsbury Square, E.C., solicitor; *J. G. B. Elliot, 18, Eldon Street, E.C., secretary; J. H. Mace, Brodrick Road, Upper Tooting, S.W., gentleman; *B. H. Van Tromp, 4, Hyde Park Terrace, W., gentleman; *E. Villiers, 3, Brechin Place, S.W., colonel; A. Schanschieff, Clifton Villa, The Avenue, S.E., electrical engineer. The first directors are those of the above gentlemen whose names are marked with an asterisk, V. Cousins, and C. Theryc. Qualification, £500; remuneration, £3,000 per annum, divisible, and percentage. Registered by John L. Higgs, 43, Finsbury Square, E.C., solicitor.

Hooper's Telegraph and India-Rubber Works, Limited (40,947).—This company was registered on the 16th inst, with a capital of £50,000 in £10 shares, to enter into an agreement for the purchase of the business now being carried on by the trustees of the late Wm. Hooper, at Millwall, to construct, manufacture, purchase, sell, deal in, lay down, let, and work, submarine and land telegraphs and telephones, electric light cables, wires, instruments, and appliances, and to carry on the business of electricians, &c. The first seven subscribers are: Wm. E. Hooper, 72, Finsbury Pavement, E.C., wool manufacturer, 100; Alice L. R. Hooper, 4 Park Hill, Clapham, S.W., spinster, 100; J. B. Hooper, 31, Lombard Street, E.C., telegraph engineer, 600; E. T. Moran, 2, Camp View, Wimbledon, 100; M. E. A. Hooper, Clapham, S.W., spinster, 100; S. F. Hooper, 87, Blackheath, S.E., clergyman, 100; A. C. Marsh, 8, Rolton Park Road, Edgbaston, 100. The first directors are J. P. Hooper and Basil Gee. Many of the rules of Table A apply. Registered office, 31, Lombard Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Domestic Telephone Company, Limited (38,563).—The statutory return of this company, filed August 3rd, 1893, and made up to July 26th, 1893, shows that out of a nominal capital of £20,000, in 3,990 A shares and 10 B shares, all of £5 each, 2,662 A shares and 10 B shares have been taken up. There has been called up on each of 7 A shares £5, and each of 655 A shares £2. The total amount of calls received is £315. Total amount agreed to be considered as paid on 2,000 A and 10 B shares, £10,050. Total amount of calls unpaid, £1,030.

The above company has no connection with that of the same name mentioned in our "Official Returns" of March 23rd last.

Telegraph Construction and Maintenance Company, Limited (1,147*c*).—The annual return of this company, made up to March 13th last, shows that the whole of the nominal capital of £448,200 in £12 shares has been taken up and paid in full.

CITY NOTES.

St. James's and Pall Mall Electric Light.

An artificial interest has been created in the working costs of the St. James's and Pall Mall Electric Lighting Company, because hitherto there has been a certain amount of difficulty in ascertaining what they really were. We have to thank Mr. Walker, the general manager and secretary, for furnishing us at last with the number of units sold during 1893. As a matter of fact, the analysis of the accounts works out admirably, and it is difficult to see why there should have been any hesitancy in giving data which would permit an analysis to be made. They are distinctly better than those of 1892, and though not quite as good as those with which one usually compares the St. James's Company, there is little with which to find fault. There is no denying that the company had an exceedingly bad year during 1893, but there is every reason to think that the close of 1894 will see a great improvement in the company's position.

The analysis is as follows:—

	1891.	1892.	1893.
Total capital expended	—	£185,329	£211,029
Number of units sold	1,067,996	1,186,826	1,211,451
Number of lamps connected ...	—	—	—
Revenue from sale of current ...	£31,149	£33,397	£29,760
Average price obtained per unit..	—	—	5·89d.

Cost of production.	£		Per unit.
Coal	4,380		·86d.
Oil, waste, water and engine room stores	701		·13d.
Salaries and wages at generating station	3,944		·78d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	1,957	Works cost 2·15	·38d.
Rates and taxes	614		·12d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	5,769		1·14d.
Depreciation of buildings and plant account	1,961		·38d.
Renewal fund account	1,291		·25d.
Total	£20,617		4·04d.

Revenue.		Average price obtained per unit.
By sale of current	29,760 0 0	—
Meter Rents	698 0 0	
Sale of Lamps	—	—
Total		

Total cost per unit (exclusive of depreciation and renewal accounts), 3·90d.; works cost, 2·05d.

The Metropolitan Electric Supply.

We have received the annual report and statement of accounts of the Metropolitan Electric Supply Company, but to do full justice to them we must wait until we receive figures to enable us to analyse the working costs.

In the meantime we note that the capital expenditure, which at the end of 1892 amounted to £550,859, now shows a total of £585,932, being an increase of £35,072, owing, as the directors say, to the continually growing extension of the company's mains, to the cost of transformers and meters, and to providing connections to the premises of the new consumers.

A dividend of 2½ per cent. is recommended by the directors to be paid on the ordinary shares.

The gross revenue for the year amounted to £69,195 against £54,571 in 1892, being an increase of £14,623, which compares fairly well with the actual increase of £13,852 in 1892. A larger increase was fully expected; but the exceptional brightness and absence of fogs during the winter months, say the directors, had a serious effect in diminishing the demand for light. In proof of this it may be mentioned that, while the revenue during each of the first three quarters of the year showed an increase of nearly 50 per cent. over the corresponding periods in 1892, the increase for the last quarter was only 8 per cent., although there was no falling off in the growth of the lamp connection.

We are very much afraid that directors will have to put up with the absence of fogs in the future. The weather which we have had for the past few months leads one to think that the fog is fast becoming, like the mammoth, extinct; we are afraid that the only fog to be found in years to come will be that carefully preserved in museums in glass bottles.

The balance to the credit of the revenue account, before providing for depreciation, is £22,913. The directors have set aside £7,000 as an addition to the depreciation fund, carrying to the credit of the net revenue account the sum of £15,913, which, with the balance brought forward from the last account, and other receipts, makes a total of £18,512. After deducting bank charges and debenture interest, there remains a balance of £14,548, of which the directors, in pursuance of the policy commenced last year, have appropriated a further sum of £1,000, in reduction of the preliminary expenses account, which is now diminished to £3,052. The dividend absorbs a sum of £12,475, which leaves a balance of £1,073 to be carried forward to the next account.

The number of 8 candle-power lamps supplied by the company increased during the year 1893 from 124,000 to 166,000. The present number of lamps connected is 175,000, and further applications continue to be received in satisfactory numbers.

Charing Cross and Strand Electricity Supply Company.

We have received sufficient data from the secretary of the company to enable us to give the following analysis:—

	1891.	1892.	1893.
Total capital invested	—	£197,729	£207,244
Number of units sold	580,131	652,703	934,276
Number of lamps connected ...	—	31,992	34,570
Revenue from sale of current...	—	19,717	£20,825
Average price obtained per unit	—	—	5·3d.

Cost of production.	£		Per unit.
Coal	4,410		1·13d.
Oil, waste, water and engine room stores	759		·19d.
Salaries and wages at generating station	2,404		·61d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	1,863	Works cost 2·40d.	·47d.
Rates and taxes	358		·09d.
Management expenses, director's remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	1,662		·42d.
Depreciation of buildings and plant account	700		·18d.
Renewal fund account	—		—
Total			3·09d.

Revenue.		Average price obtained per unit.
By sale of current	20,828 0 0	—
Meter rents	262 0 0	5·32d.
Total	£21,090 0 0	5·32d.

Total cost per unit (exclusive of depreciation and renewal accounts, 3·09d.; works cost, 2·40d.

The St. Pancras Vestry Accounts.

We have received the statement of accounts for 1893 of the Electric Light Department of the St. Pancras Vestry. There has been an increased expenditure during the year of £7,171, though this sum probably includes improvements and alterations, the benefit of which is not yet felt. The total expenditure now stands at £96,085. Bearing in mind the fact that the improvements do not yet affect the revenue accounts, it is interesting to compare the capital of two supply companies at a time when their output was similar to that of St. Pancras. Last year the number of units delivered by the Vestry was 594,893, this approximates to the output of the Liverpool Company in 1891, and to the Kensington Company in 1892; but the capital expended by the Liverpool Company with this almost equal output was £162,642, and, in the case of the Kensington Company, £152,217. Of course, it must be pointed out that the output of these two companies in subsequent years increased at a greater ratio than the capital expenditure, but still the comparison which we have made is fairly interesting.

In the matter of costs there is a distinct improvement on what was

done last year. The cost of coal has decreased from 1·66d. to 1·23d., and we must fairly consider this satisfactory, in spite of the curious and ambiguous remark made by Prof. Robinson at a recent meeting at the Society of Arts. It is not as good as the figures of the Kensington Company, with a similar output in 1892, to which we have already referred, but the decrease has been steady, and no doubt, under Mr. Baron's able management, we shall see something still better next year. The same improvement is noticeable in the salaries. In this case we have deducted the sum of £200 for engineers from the management expenses, and put them to the wages accounts.

It will be seen that the total cost is 3·45d., the working costs being 3·1d.

The analysis is as follows:—

	1891.	1892.	1893.
Total capital expended ...	—	£88,914	£96,085
Number of units sold	580,131	433,519	594,893
Number of lamps connected ...	—	—	—
Revenue from sale of current...	£18,000	£10,207	14,498
Average price obtained per unit	—	—	5·8d.

Cost of Production.	£	Per unit.
Coal	3,051	1·23d.
Oil, waste, water, and engine room stores	428	·17d.
Salaries and wages at generating station	2,679	1·08d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	1,691 (Works cost 3·16d.)	·68d.
Rates and taxes	—	—
Management expenses, engineers' department and clerical staff, stationery and printing, general establishment charges, auditors, law charges and insurance	716	·29d.
Depreciation of buildings and plant account	—	—
Renewal fund account	—	—
Total	£8,565	3·45d.

Revenue.		Average price obtained per unit.
By sale of current	14,498 0 0	5·8d.
Meter rents	239 0 0	—
Sale of lamps	—	—
Total	£14,737 0 0	5·8d.

Total cost per unit (exclusive of depreciation and renewal accounts), 3·45d.; works cost, 3·16d.

Eastern Extension, Australasia and China Telegraph Company.

The forty-first ordinary general meeting of this company was held on Wednesday, at Winchester House, Sir John Pender presiding. In moving the adoption of the report and the declaration of a dividend of 2s. 6d. per share with a bonus of 4s. per share, both free of income tax, making a total distribution of 7 per cent. for the year 1893, the chairman stated that the gross receipts for the half-year ended December 31st had been £251,000, or an increase of £4,000 over those of the corresponding period of 1892, while the working expenses had been £76,000, or £15,000 less. This decrease was entirely accounted for by the repairs to cables having cost only £21,000 during the past half-year, against £38,000 in the corresponding period of 1892. The gross receipts for the whole year had been £509,000, or an increase of £15,000 over those of 1892, while the working expenses had been £155,000, or £16,000 less. The net revenue for 1893 had been £282,000, or an increase on that of the previous year of £32,000, half of which, as he had already stated, was owing to the reduction in the expenditure for cable repairs, and the other half to increased revenue resulting from the raising of the Australian tariff, which was done at the request of the colonies, from 4s. to 4s. 9d. a word, and to the exceptionally heavy Australian traffic transmitted during the financial crisis last summer in connection with the numerous bank failures and reconstruction schemes. But for this there would have been a considerable falling off in revenue, as the working of the Australian tariff arrangements for the third year of the guarantee ending this month showed a loss estimated at between £11,000 and £12,000, notwithstanding these exceptional causes. They had also experienced a further heavy loss on exchange during the past year through the continued depreciation of the silver currency. As there appeared to be no prospect of any permanent substantial recovery, the directors had reluctantly decided to further raise the rates, where they were free to do so, from the 1st prox., so as to give the company the equivalent of their sterling charges. After paying the dividend and bonus recommended, they would transfer the balance of £107,830 to the general reserve fund, which now stood at £633,686, after they had expended £1,160,685 out of reserve on cable renewals, duplications, and triplications since the formation of the company, thus greatly strengthening and improving the market value of their property. At their last general meeting he referred to the arrangements which they had entered into with Her Majesty's Government and the British North Borneo Company for bringing Labuan and North Borneo into telegraphic communication with Singapore, Hong Kong, and the rest of the world, and at the same time strengthening the company's China system by securing an alternative line between Singapore and Hong Kong. The first section of the cable, between Singapore and Labuan, was last week completed and opened for traffic, and the remaining section, from Labuan to Hong-Kong, would be laid during the present month. The length of the new cable was nearly 2,100 nautical miles, costing about £300,000, and it would increase the total mileage of their system to a little over 18,000 miles. Negotiations with the authorities at the Hague and in Netherlands-India had resulted in their securing a special wire on the Government land lines through Java for the transmission of the international traffic by their own *employés*. This special wire gave them an efficient alternative communication to their Singapore-Banjoewangie cable, and consequently rendered it unnecessary—at all events for the present—to duplicate this section. A small station had been opened by the company at Sourabaya in connection with the new line, and they had been much gratified to learn that the telegraphing public in Java were greatly pleased at the marked improvement in the international service which this arrangement had effected. The agitation for a Pacific cable between Canada and Australasia had of late greatly increased, and Lord Rosebery had announced that the Government would send a representative to the conference to be held at Ottawa in June next for further considering the question in order to watch the proceedings. Beyond this, however, the Imperial Government did not appear to have committed itself either one way or the other. This agitation, however, was almost entirely based on sentiment on an "all British cable," as its advocates were pleased to style it. It was a moot point whether a cable, if once broken, could be picked up from such great depths as were reported to exist in the Pacific Ocean. Apart from this, a Pacific cable was not wanted to meet commercial requirements, the existing service to Australia being acknowledged to be one of the most efficient and cheapest in the world, capable of transmitting a far greater traffic than it at present carried. He urged that, as the existing system was established by private enterprise, without any Governmental assistance whatever, Her Majesty's Government could not in equity grant pecuniary aid to the proposed competing line, without subsidising or guaranteeing the company's cables to at least the same extent. If, however, a Pacific cable was required for strategic purposes, which he very much doubted, and the Governments concerned were prepared to provide the necessary subsidies to enable it to be carried out, then it would be better and cheaper for them to arrange with the company to do the work. By this means their special facilities and large experience in cable matters could be profitably utilised, and the line worked in connection with, instead of in opposition to, the present service. He then remarked that in China, where the landlines were competing with the cables, they had not yet succeeded in bringing about the friendly working between the telegraph administration and the cable companies which they had so long striven for.

The Marquis of Tweeddale seconded the motion, which was adopted.

The retiring directors and auditors having been re-elected, a vote of thanks to the chairman, directors, and the staff was passed, and the meeting closed.

Actien Gesellschaft "Mix & Genest."

The annual meeting of the shareholders of Actien Gesellschaft, Mix and Genest, of Berlin, took place on Monday last, when the report was submitted and adopted. The result of the year's trade showed a gross profit of 348,705 marks, and after writing off 78,192 marks for depreciation of plant, &c., and carrying to a reserve fund 10,000 marks, the directors were able to declare a dividend of 8 per cent. on the paid-up capital. The constantly increasing business of this company has necessitated building a new factory, as the orders, more particularly for telephone exchange work have required the renting of two additional factories. With a view to centralise the manufacturing department, the new building was designed, the estimated cost being 600,000 marks (£30,000), and the cost of acquiring the site, which is 6,653 square metres, is 340,000 marks (£17,000).

The Direct Spanish Telegraph Company, Limited.—The board have resolved as follows with regard to dealing with the £62,000 6 per cent. debenture debt, which falls due on May 1st next: (*a*) To call up the balance of £1 unpaid on the ordinary shares, £12,931; (*b*) To issue debentures for £30,000, having 20 years to run, and bearing interest at 4½ per cent. per annum; (*c*) To realise and take from the reserve fund the requisite balance, approximately £19,000, and pay off by these means the debentures falling due. The call for the unpaid £1 on the ordinary shares is made payable on May 31st, 1894.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending April 15th, 1894, amounted to £840; week ending April 16th, 1893, £861; decrease, £21; total receipts for half-year, 1894, £13,726; corresponding period, 1893, £13,717; increase, £9.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 13th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,603.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, April 11 h.	Closing Quotation, April 18th.	Business done during week ended April 18th, 1894. Highest	Lowest.
184,500/	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	100 —103	100 —103	...	...
1,134,640/	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s	41 — 43	42 — 44 xd	43	...
2,932,680/	Do. do. 6 % Pref.	Stock	£5 5s	£5 10s	£5 2s.	79 — 80	80 — 81 xd	79½	78⅜
2,932,680/	Do. do. Defd.	Stock	...	...	...	7¼— 7⅜	7⅜ — 8¼	7⅜	7½
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6½% §	6½% §	11⅝— 12¼	11¾— 12¼	12⅛	11 13/16
18,700/	Do. do. 5 % Bonds	100	...	...	...	100 —103	100 —103	...	...
75,000/	Do. do. 5 %, repayable June 1906	100	...	...	...	107 —111	108 —112	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10½% §	... §	1⅝— 2⅛	1⅝— 2⅛	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	146 —150	146 —150	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3½% §	2 % §	... §	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12 — 13	12 — 13	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18 — 19	18 — 19	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½%	4 %	4 %	2⅛— 3	2⅛ 3	2⅛	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	...	8½— 9	8½— 9	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	3½% §	...	9 — 9⅛	9 — 9¼xd	9⅛	9⅛
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	...	15 — 15¼	14⅞— 15⅛xd	15 1/16	14⅞
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	16 — 16½	16 — 16⅛xd	16	...
105,900/	Do. 5 % Debs., repay. August, 1899	100	...	...	...	107 —110	107 —110	...	...
1,294,100/	Do. 4 % Mort. Deb.	Stock	...	...	...	114 —117	114 —117	116⅛	114½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	15½— 15¾	15½— 15¾	15¾	...
62,700/	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	103 —106	103 —106	103¾	...
222,800/	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	103 —106	103 —106	...	...
320,000/	Do. 4 % Deb. Stock	Stock	...	...	...	113 —116	113 —116	114¾	114
95,100/	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	103 —106	103 —106	...	...
129,100/	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	103 —106	103 —106	...	...
300,000/	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	104 —107	104 —107	...	...
200,000/	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	107 —110%	107 —110%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	5¾% §	4⅝% §	4⅝% §	8⅞— 9	8⅞— 8⅝xd	8⅞	8⅝
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15¼— 15⅜	15¼— 15⅜xd	15 5/16	15 1/16
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	8 3/16 %	21¾— 22¼	21¾— 22¼	21⅝	...
200,000/	Do. do. do. 5 % Debs.	100	...	...	...	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	45 — 47	45 — 47	...	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	4 — 6	4 — 6	...	...
100,000/	Do. do. 6 % Debs.	100	...	...	...	106 —109	106 —109	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	½— 1½	½— 1½	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1 — 2	1 — 2	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	...	4⅝— 4⅞	4⅝— 4⅞	4 13/16	4 11/16
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	14½— 15½	15 — 16	15⅛	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	14 — 15	14½— 15½	14 1/16	14⅜
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5⅜— 5⅝	5⅜— 5⅝	...	...
925,017/	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	115 —117	116 —118	116¼	116⅛
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid ...	10	...	...	...	... ...	... ...	...	...
220,000	Oriental Teleph., Ltd., 80,001 to 300,000; 11s. paid ...	1	2¼%	3⅝%	4¼%	... ...	... ...	...	...
100,000/	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	102 —105	102 —105	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	5½— 6½	5½— 6½	...	...
3,381	Submarine Cables Trust	Cert	...	...	...	113 —118	112 —117	...	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1½— 2	1⅝— 2	...	...
146,370/	Do. do. 5 % Debs.	Stock	...	...	...	90 —100	90 —100	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	...	3 — 5	3 — 5	...	...
249,900/	Do. do. do. 5 % Debs.	100	...	...	...	100 —103	100 —103	100⅞	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2½— 3	2½— 3	...	...
150,000/	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	102 —106	102 —106	...	...
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	...	7½— 8	7½— 8	7 7/16	...
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	6 — 6½	6 — 6⅛	...	...
33,129	Do. do. do. 5 % Def. ...	7½	3 %	...	...	2 — 2½	2 — 2½	2⅛	...
178,200/	Do. do. do. 6 % Debs. "A," 1910 ...	100	...	...	...	105 —108	105 —108	108	...
222,700/	Do. 6 % Mort. Debs, series "B," red. Feb. 1910	100	...	...	...	105 —108	105 —108	106⅛	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	...	1⅛— 1⅛	1⅛— 1⅛	1 1/16	1 1/16
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	10¼— 10⅜	10⅛— 10⅜	10⅜	10⅜
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	...	9 — 10	9 — 10	...	...
80,000/	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	107 —110	107 —110	...	...
$1,214,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	113 —118	113 —118	...	...
169,000/	Do. do. 6 % Ster. Bonds.	100	...	...	...	100 —104	100 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

20,510	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½%	4 — 5	4 — 5	...	...
40,000	Cityof London Elec. Lightg. Co., Ltd., Ord. 40,000—180,000	10	...	...	...	11½— 12⅝	11⅝— 12½	12½	12¼
20,000	Do. do. 6 % Cum. Pref., 1 to 20,000	10	...	6 %	6 %	13¼— 13⅜	13¼— 13⅜	13⅜	13¼
19,900	*Electy. Supply Co. of Spain, 101 to 20,000...	5	...	...	...	... ...	... ...	...	...
5,523	†Liverpool Electric Supply, £4 10s. paid	5	...	...	...	5⅛— 6½	5½— 5⅝	5⅝	5⅝
39,477	Do. do.	5	4½%	5 %	5 %	6 7/16— 6 9/16	6⅛— 6⅜	6⅜	6¼
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000 ...	10	1 %	2 %	...	7½— 8	7¼— 7⅜	8	7½
100,000/	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	106 —109	106 – 109	109	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	4½— 5⅛	4⅝— 5½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8⅛%	7½%	4½%	6¼— 6⅜	6¼— 6⅜	6 11/16	6½
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 8¼	8 — 8½	8¼	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3½%	4 %	5⅜— 6¼	5⅞— 6½	5 15/16	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ¶ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, April 11th.	Closing Quotation, April 18th.	Business done during week ended April 18th, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	3 — 3¼	2⅞ — 3¼	3⅛	2⅞
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2⅛ — 2⅜	2⅛ — 2⅜	2 3/16	2⅛
125,000/	Do. do. 4½ % Deb.	Stock	...	...	...	108 —111	108 —111	109½	...
630,000/	City and South London Railway	Stock	...	⅝%	⅝%	27 — 32	27 — 32	...	...
20,000	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 20,000	5	7 % §	7 % §	7 % §	3½ — 4	3¼ — 3¾	3 3/16	3⅜
50,000/	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	95 —100	95 —100	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	½ — 1	½ — 1	¾	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1½ — 2	1¼ — 2	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd, 1 to 66,750 ...	2	*nil*	*nil*	*nil*	¼ — ⅜	¼ — ⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	¼ — ⅜	¼ — ⅜	...	...
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	½ — ¾	½ — ¾	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½ — 1½	½ — 1½	...	...
12,134/	Greenwood & Batley, Ltd., Ord., 4,667 to 16,800	10	...	...	...	4½ — 5½	4½ — 5½	...	...
9,600/	Do. do 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½ — 7½	6½ — 7½	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	23 — 24	23 — 24	23⅜	23¼
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	101 —103	101 —103	...	...
11,334	International Okonite, Ltd., Ord., 22,667 to 34,000 ...	10	5 % §	...	...	1 — 2	1 — 2	..	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	7¼ — 7¾	5½ — 5½xd	7 1/16	5
6,295	† Do. do. Pref., £8 paid	10	...	...	...	11⅜ — 12½	9 — 9½xd	...	...
78,949	Swan United Electric Light, Ltd., £3½ paid	5	11 % §	10 % §	7½% §	2 — 2½	2 — 2½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	39 — 41	38 — 40	40	39
150,000/	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	... ...	... ...	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0% §; 1891—7% §; 1890—8% §.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—5⅝.
Brush Company, 4½ % Debenture Stock, issued at 1 % premium, 106—108.
Electric Construction Corporation, 6 % Debentures, 87—92.
Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.
Electricity Supply Corporation, Ordinary of £5, 5—5¼.
House-to-House Company (£5 paid), 1—1½.
Do. do. 7 % Preference, of £5, 5¼—5½.
Do. do. 6 % Debentures of £100, 101—103.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4⅜—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6⅜.
Liverpool Electric Supply, £5 (fully paid), 6½—6⅝.
Do. do. £3 10s. paid, 4½—4⅝.
London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

Transparent Conducting Screens for Electric and Other Apparatus, by W. E. Ayrton, F.R.S., Past-President, and T. Mather, Associate. (Read Thursday, April 12th, 1894.)

It is well known that electrostatic instruments require to be screened from outside electric disturbance, in order that their indications may be correct; but it is not so generally recognised that instruments intended to measure small forces, such as certain types of *electro-magnetic* voltmeters, delicate vacuum gauges, &c., are liable to give wrong readings from an electric attraction being exerted on the pointer, such as is produced by the glass cover when it is touched or cleaned.

There is on the table here a well-known type of gravity *electro-magnetic* voltmeter, which may be found on the switchboards of many English and continental electric light stations. At the present moment its terminals are not connected with the electric light mains of the building, so that it should indicate zero pressure. Let me, however, but stroke the right-hand side of the glass cover with my finger, and the pointer, as you see, at once turns to 80 volts or more. Conversely, let the terminals of the voltmeter be connected with the electric light mains: the pointer should point to about 100 volts, for that, as you know, is the pressure supplied by the Westminster Company. The voltmeter appears to be indicating correctly, but, on stroking the left-hand side of the glass cover, the pressure as read by the instrument, appears to suddenly fall to some 40 volts. And a similar effect is produced if a piece of wash-leather or dry waste be used in place of the finger.

If, then, it is possible to cause this instrument to indicate at will 60 or 80 volts too high or too low, how impossible must it be or feel sure that the glass cover—which is, of course, maintained in a dry condition in a hot engine room—has not been electrified by some accidental touch of the coat sleeve sufficiently to cause an error of 3 or 4 per cent. in the reading of this voltmeter.

We find that it is not merely with this particular type of voltmeter that an error can be produced by stroking or rubbing the glass cover, for other electro-magnetic instruments that we have tried can also have their pointers deflected in the same way, but not to the same extent.

Nor, of course, is this source of error in any way connected with a voltmeter being an instrument constructed to measure an electrical magnitude, for it would equally exist if the glass were clean and dry and the controlling force remained of the same magnitude, no matter what was the quantity the instrument was constructed to measure.

For example, on the table there is a vacuum gauge the wheel-sector-pinion of which has been replaced with an Ayrton-Perry magnifying spring. This gauge is, no doubt, very sensitive, for you observe that the pointer moves even when I produce an extremely slight diminution of pressure by rotating the short length of India-rubber tube as slowly as I can; the change of pressure on pinching the tube, or even on dropping it, is indicated by the pointer. On the other hand, the pointer is of glass, and therefore is not suitable for being acted on by an electrostatic force; still, a stroke on the glass cover, as you see, causes the pointer to deflect through several degrees.

It has been known for a long time that it is possible to screen an instrument from such outside electrostatic disturbances by surrounding it with a metallic cage composed of wire or of strips of tinfoil. Such a method of screening, however, has the great disadvantage that it renders it difficult to observe the exact position of the pointer from a distance, for the wires or strips of tinfoil cover up the pointer more or less. We therefore thought of placing the pointer underneath the metallic dial of our electrostatic voltmeters, and of only allowing the tip to project through a slot in the dial plate. But this method we abandoned on trying it eighteen months ago, for to make the screening good the visible part of the pointer must be reduced to a spot, and the exact position of this spot we found less easy to read at a distance of several feet than that of a long black line, which is the appearance of a pointer when it is visible along its whole length. This method of screening has, however, we understand, been recently adopted by a firm of instrument makers.

We next considered whether it was not possible to make a perfectly transparent conducting screen, so that, while the electrostatic screening of the pointer should be practically perfect, the pointer and dial should be as easily seen as if the screen were not present. Our first idea was to make the glass cover double, and to insert between the two sheets of glass a layer of clear conducting liquid. Fearing, however, trouble from leakage of the liquid, or from the liquid becoming gradually turbid and giving the dial a dirty appearance, we turned our attention to depositing films of solid matter on the inside of the glass cover, or shade, of sufficient thinness to be practically transparent, but with the solid particles near enough together to be conducting. We tried smoke, silver deposited in layers of various thicknesses, mercury vaporised and deposited, sal-ammoniac vaporised and deposited, &c., but we were quite unable to obtain in this way both transparency and electric conduction.

After a conversation with Prof. Boys, when discussing the problem that we were then engaged in solving, we commenced experimenting

on varnishes, with the view of arriving at a varnish which should be as hard and as transparent as *clear* shellac, but which, instead of being an insulator like shellac, should be a sufficiently good conductor to allow of the instantaneous production of an induced electric charge to balance the electro-static action of any outside body. Glass plates were coated with gum, with coaguline, with the gelatinous electrolyte used in accumulators (composed of sodium silicate and dilute sulphuric acid), with isinglass dissolved in acetic acid, with gelatine dissolved in acetic acid, with isinglass dissolved in a mixture of acetic and sulphuric acids, and with gelatine dissolved in the same mixture. After much experimenting, we arrived at the following two methods of coating a glass cover, or shade, which gives perfectly satisfactory results:—

No. 1. Dissolve ¼ ounce of transparent gelatine in 1 ounce of glacial acetic acid by heating them together in a water bath at 100 degrees C. To this solution add half the volume of dilute sulphuric acid which has been prepared by mixing one part of strong acid with eight of distilled water by volume, and apply the mixture while still warm to the glass shade, which should be previously polished and be warm. When this film has become very nearly hard, apply over it a coating of Griffith's anti-sulphuric enamel.

Method No. 2.—Thin the gelatine solution, prepared in the manner previously described, by the addition of acetic acid (say two volumes of acid to one of the solution), and, after polishing the glass, float this thinned solution over the glass cold. Drive off the excess of acetic acid by warming, allow the glass to cool, and repeat the floating process, say, twice. Thin the anti-sulphuric enamel by the addition of ether, and float it over the gelatine layer applied as just described. Expel the ether by heating, and apply a second layer of this thinned anti-sulphuric enamel.

With experience, such as Messrs. Elliott and Messrs. Paul have at length acquired after much practice, a layer can be applied, either according to method No. 1 or No. 2, so that, when finished, it is quite hard to the touch, and so transparent that it is only by looking at the glass plate obliquely that the presence of the varnish can be detected. It is also so conducting that when a P.D. of several thousand volts, alternating with a frequency of 200, is set up between the needle and inductors of one of our electrostatic voltmeters, the pointer, which is metallically part of the needle, is not visibly attracted by a metallic rod held just outside the glass close to the pointer, this metallic rod being electrically connected with the stationary inductors.

Without experience, however, it is somewhat difficult to apply the coating so that it is not either cloudy, or a comparatively poor electrostatic screen, or both.

This second electro-magnetic voltmeter—which, like the former, has been kindly lent us by Mr. Barley, of the Knightsbridge electric light central station—looks exactly like the other one when we received it. It has, however, had a layer of our transparent varnish applied on the inner side of the glass subsequently, and you will find that you may rub the glass as much as you like, or even hold a rubbed stick of ebonite near it, without producing any effect on the pointer.

Again, these two clear glass shades, belonging to gold-leaf electroscopes, are one of them coated with our varnish and the other not. Which is the uncoated one is at once apparent from the alteration produced in the deflection of the gold leaves when I approach a stick of rubbed ebonite near the lower part of the glass shade of the uncoated one, for no such change in the deflection is produced, as you see, when the ebonite rod is brought near the glass shade which is protected by a layer of this varnish applied on the inside.

An Astatic Station Voltmeter, by W. E. Ayrton, F.R.S., Past-President, and T. Mather, Associate. (Read Thursday, April 12th, 1894.)

The rapid development of electric lighting generating stations during the past three years has resulted in a greatly increased perfection in the regulation of the pressure, and consequently has created a need for measuring instruments of much greater precision than was previously required. At the same time, the powerful dynamos now employed, and the large currents, that flow through the mains on the switchboards at these generating stations, has greatly increased the disturbing influences to which electro-magnetic measuring instruments are subjected. Consequently, it is not to be wondered at that voltmeters and ammeters which answered fairly when the output of the stations was small, have had to be discarded as being unsuitable for the present requirements.

The authors have, therefore, been engaged for some time past in developing an electro-magnetic voltmeter to fulfil the following conditions:—

1. Be unaffected by an outside magnetic field, whether uniform or not, and as strong as the disturbing magnetic field on any ordinary central station switchboard.
2. Be unaffected by an outside electrostatic disturbance such as is produced on rubbing the glass front of the instrument.
3. Have no temperature error.
4. Have a high resistance, so as to measure equally accurately the *true* pressure at the end of long thin pilot wires, or in the station itself.
5. Have a scale of large radius, and one very open at the working pressure, so that a small change in the pressure can be detected.
6. Be dead beat.

Condition No. 1 is most easily fulfilled by employing a powerful stationary permanent magnet and moving coil, for such an arrangement has the great advantage that it cannot indicate a pressure unless a current be actually flowing through the coil; whereas soft iron and other types of voltmeters, when placed in a fairly strong magnetic field, may have the pointer deflected across the scale when no current whatever is passing through the instrument. But it is not sufficient to merely employ one permanent magnet and one moving coil, as is proved by the fact, which is probably not generally known, that the very beautiful Weston voltmeter,* in spite of the permanent magnet being strong and the air gaps in which the coil moves being extremely small, indicates slightly differently when put in different positions in a magnetic field even as weak as that of the earth's, the change in the reading being about one-fifth per cent. when the instrument is placed horizontally and turned through an angle of 180 degrees in a horizontal plane. This voltmeter therefore cannot, of course, give constant indications in a varying magnetic field 50 or 100 times as strong as that of the earth's. Now Messrs. Clark and Malpas have found, by experimenting with our portable magnetic field tester, that a field of 20 C.G.S. units, or one rather more than 100 times as large as that due to the earth, is the sort of magnetic disturbance that occasionally occurs on the switchboards of existing central stations, while fields of six C.G.S. units—that is, 30 times the earth's field—are quite common.

If the coil be wound astatically, and be acted on by two powerful permanent magnets inside the voltmeter, with their poles oppositely directed, good screening can be obtained from a uniform disturbing magnetic field; but errors will be produced if the disturbing field be *non*-uniform, such as is caused by a mass of iron, or by a conductor carrying a current, placed near the voltmeter. We have, therefore, carried this principle of astaticism further by employing *three* permanent magnets and a coil wound in three parts, as shown diagrammatically in fig. 1, the area of the middle coil being double that of

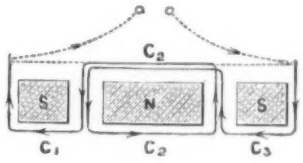

Fig. 1.

either of the end ones; and in this way we have obtained an arrangement which is comparatively unaffected by either a uniform or a non-uniform magnetic disturbance.

The moving coil principle also enables conditions 3 and 4 to be fulfilled, for the resistance of this 100-volt instrument is about 7,000 ohms; and as only 3 per cent. of this is composed of copper wire, viz: that wound on the moving triple coil, while 97 per cent. is of manganin wire, indicated by the stationary coil, R, in figs. 2 and 3, the temperature error is practically negligible. This high resistance also causes the power required to actuate the voltmeter to be very small, not more than about 1½ watts being absorbed at 100 volts with this voltmeter.

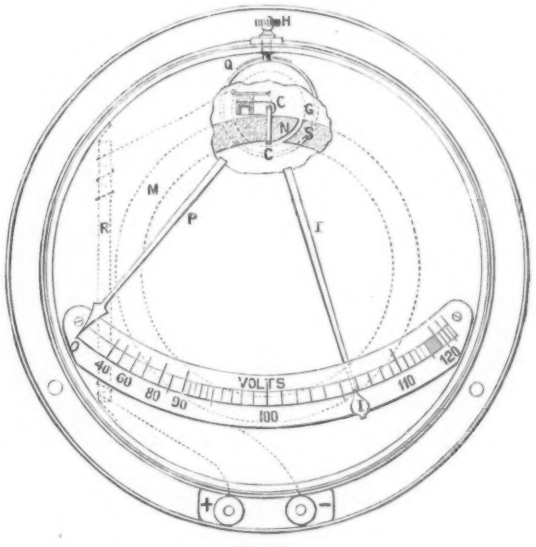

Fig. 2.

The control is produced by a weight, because this is the method of exercising a controlling force that is least likely to vary, and because the objection to the employment of a gravity control—that the voltmeter cannot be used in any position—is of no importance in the case of a switchboard instrument.

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* Tests made from month to month of the sensibility of two of the latest form of the Weston voltmeter show also that the sensibility slowly *increases*. This arises, probably, from the permanent magnets having been too much weakened before these instruments were originally calibrated, so that the magnets have *increased* their strength with time. These two instruments now read 1·3 per cent. and 1·7 per cent. too high respectively, after allowing for the fact that the unit P.D. employed in the original calibration was the legal volt, and not the "Board of Trade" or "International" volt.

Fig. 2 shows the voltmeter in elevation, while fig. 3 gives a plan; both figures being drawn partly in section, so that the working parts may be more clearly seen. The triple coil, C_1, C_2, C_3 (fig. 1), passes over the poles of the three magnets, M_1, M_2, M_3 (fig. 3), the direction of the winding being such as to cause the deflecting forces for each portion of the coil to be in the same direction. The current is led up to and away from the coil by very thin flexible silver strips attached to the points of the stationary pieces, *w*, *w'* (fig. 3).

Conditions 5 and 6 are satisfied by specially shaping the air gaps, and we find that without sacrificing the quickness of motion of the pointer, P, too much, we can flatten the calibration curve at the working part of the scale so that $\frac{1}{100}$th part of a volt variation in the pressure can be detected.

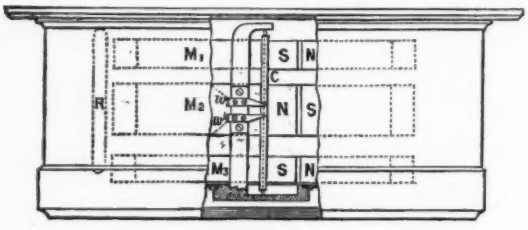


Fig. 3.

A bit of the scale, *full size*, is seen in fig. 4, and, although large and bold, an additional means for indicating whether the pressure is correct or not is provided by means of the index, I (fig. 2). This index can be moved and set at any desired position by turning the milled head, H, which actuates a crown wheel segment, Q, carried by the ring to which the arm, I, is attached. This index arm is coloured *red*, while the pointer, P, and the arrow-head at the lower end of the index arm are coloured *black*. If the pressure be exactly right, the red index arm is entirely covered by the black pointer; whereas, if the pressure be high or low, red is seen to the left or right of the pointer respectively. An attendant can, therefore, see from a distance of many yards whether the pressure has exactly the desired value, or is

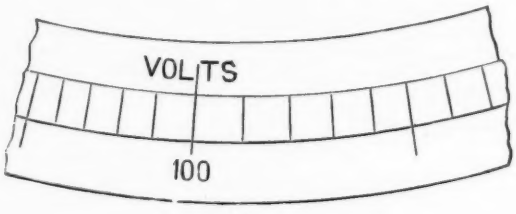


Fig. 4.

above or below it. The same milled head, H, works the arrangement for clamping the moving parts during transport; but this clamping device is so arranged that the moving parts cannot be clamped as long as the pointer is on any part of the graduated scale; hence there is no risk of the coil and pointer being accidently clamped while the voltmeter is screwed up to the switchboard. To clamp the moving parts before removing the voltmeter, take out the two side screws that hold the voltmeter to the switchboard, and turn the instrument around the top screw until the pointer is deflected to the left of the graduated scale; then turn the milled head so as to bring the index up to the pointer, when the moving parts will be firmly clamped.

Lastly, the inside of the glass cover is coated with a layer of our transparent conducting varnish, described in the previous paper read to-night, and the instrument is thus screened from outside electrostatic action. Hence there is no fear of a change in the reading being produced by cleaning the glass—a very serious source of error, which is not uncommon with electro-magnetic voltmeters in actual use in electric light central stations.

Northern Society of Electrical Engineers.

A well attended meeting of the above society was held on Monday at the Palatine Hotel, Manchester, Mr. W. P. J. Fawcus, of the Manchester Edison-Swan Company, in the chair. The first business was the adjourned discussion on two papers read at the previous meeting by Messrs. Ryder and Clirehugh on "Electrical Mains," in the course of which Mr. Wooler remarked that one advantage which bare copper possessed was the ease with which surface connections could be made. Mention had been made in one of the papers of fires and explosions; with cables under the drawn-in system, they would have to be renewed, jointed, and vulcanised, whereas with copper strip, the blackening could easily be cleaned, and a little adjustment would serve to rectify the injury. Flooding could not occur with a bare copper system properly set up. With regard to Mr. Clirehugh's suggestion as to the use of soft soap to ease the cables when being drawn into the pipes, he might remind them of the importance of using nothing but pure neutral soft soap, as otherwise the acids would have an injurious effect.

Mr. Corlett said with regard to the actual cost of maintaining a copper strip system, he had obtained figures as to the cost of the mains, and of maintenance for the Kensington station. The total cost of the mains was £56,000, and the cost of maintenance, including repairs to the working parts caused by the wearing away of the cement, &c., from 1888 to 1893, inclusive, was about £862, which was only about 4 per cent. per annum on the prime cost of the mains.

Mr. Callender said that when the matter was really looked into, it was surprising to find how little vulcanised rubber cables were being used—and he thought vulcanised rubber was now becoming less used for the majority of mains, especially distributing mains. He had made out a list of stations in England, Scotland and Ireland, either in work, in course of construction, or the contracts for which were definitely settled. In all there were 82 stations, and he had noted the number of cases in which each of the different systems was used. In six stations the system used had been very equally divided between rubber, strip, vulcanised bitumen, &c. In 25 stations vulcanised rubber was used, but only in four cases was rubber used throughout for low tension, although in eight stations rubber was used in connection with strip; where crossings had to be made and bare copper strip could not be applied rubber was used. Then there was the lead-sheath system, which was adopted in 19 stations, including Derby, St. Pancras, Glasgow, Dewsbury, Southport, Harrogate, Yarmouth, Brighton, Rochester, Crystal Palace, &c., and although this method would not do for every place, it was one of the systems which would well hold its own in the future, and for high tension feeders nothing better could be got.

Mr. Nisbett said he did not think that vulcanised rubber cables stood at the top from a scientific standpoint.

Mr. Ryder, in replying upon the discussion, said he thought the members would agree with him as to the advisability of using a drawing-in system for feeders, and an armoured or built-in system for feeders. There was a great future for armoured cables. Lead-covered cables were all right when the lead was properly prepared and put on cold, and there was no fear of any pinholes.

Mr. Clirehugh also replied upon the discussion, but remarked that there was nothing that called for special notice from him beyond what had already been touched upon.

Mr. R. P. Wilson next read a paper on "Electricity Meters."

In this paper great care has been taken to eliminate as far as possible the historical element, and while the author is anxious to give unsuccessful inventors every credit for their efforts which have largely assisted in the production of the few meters which may be said to be commercially alive at the present day, he has confined himself to the description of the few that represent the survival of the fittest.

When the system of charging for electricity at so much per lamp per annum was tried it was found to result in endless dissatisfaction, and now no "undertakers" would dream of charging (except under very special circumstances) and no "consumer" would dream of paying for his current on the "contract" system.

As specified by the Board of Trade, the duty of an electricity meter is to ascertain and integrate the quantity of electrical energy ($E \times C_t$) supplied to an installation. Many engineers, however, are content to use ampère-hour meters and to assume that the voltage on their mains is constant, whereas the author is given to understand that in some cases this cannot be relied on even with that degree of certainty which has been attained by gas lamps when there is water in the pipes.

The earliest form of meter used was that designed by Edison, in which a portion of the current to be measured passed through a cell containing a solution of sulphate of zinc, in which are immersed a positive and negative electrode, both of zinc, the current being measured by weighing the plates at intervals, and thus ascertaining the weight of metal transferred from one plate to the other. After each measurement or meter reading the poles are reversed and the metal deposited is transferred back to the original positive plate, which now becomes the negative electrode of the cell. It was found, however, that the back E.M.F. of the cell varied with the temperature, so that it became necessary to compensate for the error thus introduced. This is effected by inserting in series with the cell a small copper wire resistance, whose value varies with the temperature, whereas the resistance of the cell varies inversely as the temperature, so that the resultant resistance remains practically constant. The larger part of the current passes through a German silver resistance forming a shunt across the cell; in fact, only ·025 of the whole current is measured, so that any error in the chemical balance used to weigh the amount of metal deposited is multiplied enormously, and though this is a serious objection to the principle, this meter is still very largely used abroad, but only to a very moderate extent in this country.

A further difficulty is that the electrolyte in the cell is liable to freeze; to obviate this a double metal strip, consisting of two metals whose temperature coefficients are different, is introduced. The two metals are fixed together at both ends, and supported at one end only; under the other end is an adjustable contact screw, so arranged that when the temperature falls below a predetermined point and alters the curvature of the double metal strip, it makes contact with the screw, and by doing so completes the circuit of an incandescent lamp, the heat of which is sufficient to maintain the necessary temperature in the meter case. In cold climates this is, of course, an insuperable objection to the use of the meter, as the station would be called upon to supply current for a number of lamps for which they would, of course, receive no revenue.

Another form of electrolytic meter was devised by Messrs. Lowrie Hall & Kolle, for use on an alternating current, and consisted of an accumulator in series with the customer's transformer. The effect of this is, of course, to add ½ volts to the E.M.F. of the positive side of the alternation, and to diminish those of the negative side by a similar

amount; the whole current to be measured passed through the accumulator, and the electrolytic bath was acted on by the two volts passing continuously in one direction, the current passing through it, and consequently the metal deposited being of course proportional to the lamps alight.

It will be seen that if any lamps are left turned on when the primary of the converter is switched off, the accumulator continues to discharge through these lamps, and the electrolytic action in the meter cell continues.

The necessity of using a chemical balance to ascertain the consumption of energy in a consumer's premises is very inconvenient, and the consumer himself is not always provided with that childlike faith which is so essential when he cannot take his own meter readings.

It is now an axiom that meter dials shall be so constructed that they do not require interpretation by an expert.

The above are the only two electrolytic meters which have been used commercially; others have been invented, but their existence has been ephemeral.

The meters most largely used in this country now are the following:—

1. The Aaron ampère-hour and wattmeters, direct and alternating.
2. Thomson-Houston wattmeter, direct or alternating.
3. The Schallenberger ampère-hour meter, alternating only.
4. The Ferranti ampère-hour meter direct current.
5. The Chamberlain and Hookham direct current ampère-hour meter.

This order approximately represents the extent to which the various types are in use.

1. *The Aaron Meter*, designed by Dr. Aaron, of Berlin, was the first practical meter exploited, and many a central station owes a great deal to Dr. Aaron.

This meter is of the independent motor type, and has gone through many modifications. It consists now of two clocks mounted together on one common base, each driving one wheel of a differential gear; between these two bevel wheels is a third which gears with both, but which, being free to revolve on its axis, communicates no motion to the dials so long as the two clocks are absolutely synchronous. Of the two pendulums, one is provided with a weight in the ordinary way, and its only duty is to beat seconds with constant regularity, the other is provided with a weight in the form of a permanent magnet in the direct current ampère-hour meters, or a fine wire coil in the case of the wattmeters. In the first case the permanent magnet (which beats seconds) normally oscillates over the end of a solenoid in series with the circuit whose consumption is being measured, and the value of each of its beats varies in proportion to the current passing through the solenoid.

In the second case (the wattmeter) the permanent magnet is replaced by a fine wire coil oscillating through a solenoid, the resultant effect on the pendulum is proportional to $C \times c$ or $C \times E$, because c varies, of course, with the E.M.F.

3. *The Schallenberger Alternating Current Ampère-Hour Meter.*—This meter, which is the invention of Mr. Schallenberger, one of the engineers of the Westinghouse Company, is one that has undergone probably less modifications than any other meter in the market, excepting the Edison. Its action may be explained as follows:—The current to be measured passes through the series coils, inside which is what may be described as a short-circuited secondary coil, fixed with its axis at an angle of about 45° from that of the series coil. Enclosed in both these coils is a soft iron ring, mounted horizontally on a vertical shaft. The current in the series coil induces in the short-circuited secondary another current, in which the current lags a quarter of a period, with the result that these currents which are continually reversing, produce rotation in the iron ring which communicates its motion to the registering mechanism. In this meter the velocity attained is approximately proportional to the square of the speed, and the square root is extracted by the resistance offered by the air to the revolution of a 4-winged aluminium fan, mounted at the lower extremity of the shaft. It may be well to point out that the retardation produced by any such fan varies with the barometric pressure, that is to say, with the density of the atmosphere. The meter, however, is very largely used with very satisfactory results, but only in comparatively small sizes, as far as the author is aware.

4. *The Ferranti Direct Current Meter.*—The rotation of this meter is produced by passing a current radially through a bath of mercury situated in a magnetic field. Immersed in the mercury is a fan attached to a vertical shaft, which communicates its rotation to the registering mechanism. The torque produced by the current in the series coil which is used to establish the magnetic field above referred to, and to pass through the mercury, would produce a rotation whose velocity would be proportional to the square of the current; this is retarded by means of the fluid friction set up by the moving of the mercury against the side of the vessel containing it. This fluid friction corresponds to the fans in the case of the Schallenberger meter. A meter on this principle was originally invented and exhibited by Lord Kelvin at the Health Exhibition. Since that time Mr. Ferranti made, with a certain amount of success, some alternating current meters on the same principle, but they were not commercially as successful as the direct current type, and have since been abandoned. The initial friction in this meter is counteracted by making the core of the solenoid, on which the series coil is wound a permanent magnet, which takes the place of a shunt circuit such as is generally used. A great deal of difficulty was experienced in getting mercury that was chemically pure, and in preventing the rusting of the steel shafts, but the author has been given to understand that these difficulties have since been overcome by methods which Mr. Ferranti is evidently anxious to keep to himself, as a request for further information on this subject elicited no reply. These meters are manufactured in a very neat compact cast-iron case, and they were the first to contain the double sealing arrangement, which, although suggested by the Board of Trade, had been adopted by Mr. Ferranti before that time.

5. *Chamberlain-Hookham Meter.*—The older form of this meter was very similar in principle to the Thomson, in that the retarding arrangement consisted of a copper disc revolving between the poles of a permanent magnet. The motor part consisted of a number of coils wound flat, and fixed to the copper disc, the current being carried to the armature coils by means of a commutator rotating in mercury cups. The action of the instrument was thus a motor in which the armature carried the current to be measured, and a constant field in the form of a permanent magnet. This form of meter has, however, been entirely superseded by the new type, which is almost a different meter altogether. Like the Ferranti, it consists of a mercury bath carrying a disc, through which the current to be measured travels radially, the intensity of the field being varied by a series coil wound on one of the cast-iron polar extensions, and a further winding wound on an iron bar attached to the cover of the bath, so that the total induction through the permanent magnets remains practically unchanged. A very ingenious device for reducing the friction of the rotating disc consists of attaching to the disc immersed in the mercury a second disc of vulcanised fibre, which, owing to its small specific gravity, compared with that of mercury, tends to reduce the weight on the lower bearing.

The difficulty of rendering permanent the magnets so largely used now in this and other meters, has been practically overcome, so that there is no objection to their use.

Before leaving the subject of meters altogether, it may be well to mention the Ferranti-Wright meter, but as this meter is not very largely used it will be unnecessary to devote more than a very few words to it.

The series coils and shunt coils are wound on cores of laminated wrought-iron having elongated polar projections, between which is placed a closed metallic ring. The progressive poles in these elongated pole-pieces alternate successively, and thereby produce rotation in the conducting disc, which is proportional to the square of the current, the retardation being induced by means of a fan as already explained. This meter depends for its action partly on the hysteresis in the iron and partly to the reaction of the current in the metallic ring revolving between the poles.

In conclusion, the most important and least appreciated meter at present on the market has been invented by Mr. Arthur Wright, of Brighton, viz.:—The Maximum Demand Meter. A very full description of this instrument and its advantages appeared in *Lightning* of December 28th, 1893. The author begs to refer you to this article as containing full information on the subject, but the following remarks will serve to impress upon you the value of this addition to the outfit of a central station.

A supply of electricity is not similar to a supply of gas, for the reason that the latter may be always produced under the most favourable conditions, whereas in the case of the electric light the maximum output required at any given time is a measure of the plant required in the central station. In view of the fact that electric light companies are not philanthropic institutions, it is evident that the most important duty of a central station engineer is to make a profit. This can only be done by encouraging such customers as have a large consumption and a small number of lamps. Very many systems have been introduced from time to time, to popularise the use of electricity, but the only one which produces the desirable customer is the method adopted by Mr. Wright, *i.e.*, to encourage a large consumption and diminish the maximum demand at any one time. This he has succeeded in doing by his method of charging at Brighton, which is as follows: The "maximum demand" meter is fixed in each customer's premises, and registers the total ampères required at any one time during the quarter. After a certain number of watts have been used during the quarter (corresponding to this maximum demand, for two hours a day) all further current supplied is charged at half price, so that consumers have every inducement to increase their consumption by putting lamps all over the house, and they also have every inducement to minimise the number of lights turned on at any one time. As Mr. Madgen points out, a customer having 10 lamps burning 10 hours a day only requires plant for 10 lamps that burn the same amount of light as a man who has 100 lamps which he burns for one hour, whereas the man with the 100 lamps requires ten times as much plant, and to all intents and purposes, the same standing charges.

The principal difficulty these meters present is in keeping the clocks synchronous. Several modifications have been introduced from time to time to effect this; the one most frequently used consists of a loose thread attached to both pendulums carrying a small weight in the middle. But the difficulty has been entirely obviated in a modification introduced by Mr. Miller, of the Kensington and Knightsbridge Company, in which the second clock is dispensed with entirely.

The one clock drives a copper disc whose speed is retarded by the current in the series coil before which it revolves.

Mr. Miller is also responsible for another very ingenious modification of this meter, which by making its curve the same going backwards or forwards enables it to be used to ascertain the efficiency of a secondary battery, and practically the energy it contains at any period of its discharge, by enabling the meter to reduce its reading during the discharge by revolving in the opposite direction.

Before leaving these meters it may be well to draw attention to the Oulton-Edmondson meter, which, although not very largely used in this country, has many points in its favour. Like the Aaron, it consists essentially of two pendulums vibrating in unison until interfered with by the retarding influence of the series coil, but the mechanism driving these pendulums is electrical throughout; their unison being maintained by communicating the vibrations of one to the other by means of a rigid bar in place of the thread and weight referred to above.

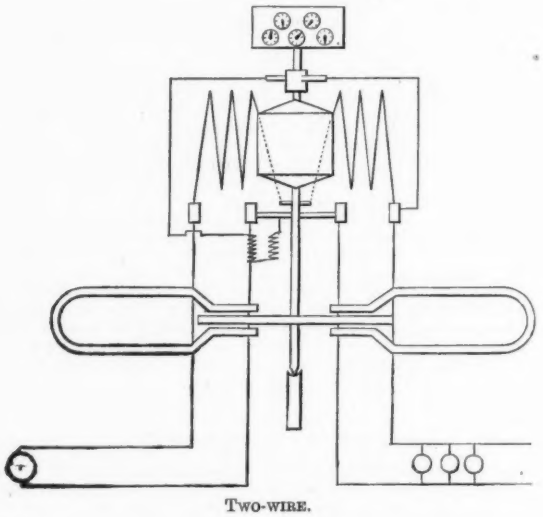
The total consumption of each of these meters is 2 watts per hour,

and they have some advantages over the Aaron in that they do not require winding or an expert watchmaker to set them up and keep them in repair, and their pendulums do not vibrate except when current is being used.

2. *The Thomson-Houston Wattmeter.*—This instrument is one whose invention has been claimed by a large number of professors and others, but was presumably originated practically by Prof. Elihu Thomson. It consists of a motor wattmeter whose armature has a vertical shaft extending through the series coil top and bottom, and communicating with the registering mechanism above, and carrying a copper disc at the bottom. This disc revolves between the poles of three permanent magnets; this combination forms a dynamo with a short-circuited armature whose Foucault currents by reacting on the field magnets generating them produce a retarding effect on the armature shaft which is proportional to its speed, so that the ultimate speed of rotation is directly proportional to the torque represented by $C \times c$. This is, of course, only correct assuming that the effect of friction has been eliminated. To do this the amount of friction has been reduced to a minimum by having a jewelled bearing mounted on a spring at the bottom, and a guide only at the top, and its effect, which may be taken to be constant for all speeds, has been counteracted by allowing the armature current to pass through the series coil first, so that at all times the initial torque is such that the friction error is negligible.

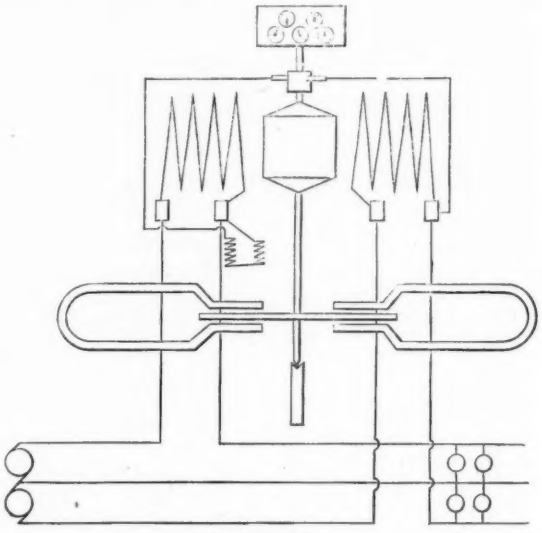
This meter may be used indiscriminately on direct and alternating currents, as the added resistance in series with the armature is a very large proportion of the whole, and is wound non-inductively, so that up to about 130 periods per second the self-induction may be neglected; as a matter of fact, in practice, if it is found that the difference in the constant of the meter when used on a direct current and on a circuit of 130 periods is less than 1 per cent.

They are also constructed for three and five-wire circuits; the connections are respectively as follows:—

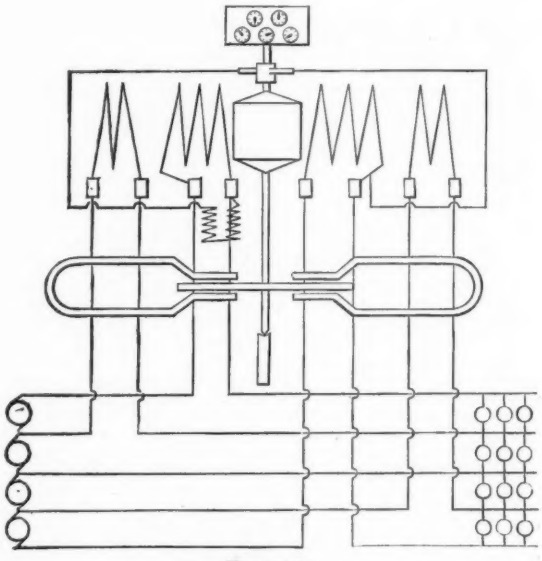


Two-wire.

The action of the former is simple enough, each of the series coils exerts a torque corresponding to $C/2 + c$, but it must be remembered that c is $= 200/r$, whereas C is $= 100/R$. The five-wire meter is rather more involved, because it will be seen that the current in the coils, B and C, may be travelling in either direction. The result under any given circumstances may be best demonstrated by taking an example. Let total E.M.F. = 400 volts, and let us assume that the current in each of the five conductors is as follows:—A 100. B 25. C 25. D 25, and E 25 ampères. The 25 ampères in B is opposing the meter's rotation in the direction of the torque produced by A C, D C, and E C, so that it will ultimately register $(A\,C/2 - B\,C/1 + D\,C/1 + E\,C/2)$, c being, as before, proportional to the whole potential difference between A and E, that is to say, the total watts coming out of the station $= (100/2 - 25/4 + 25/4 + 25/2)\,400 = 25{,}000$.

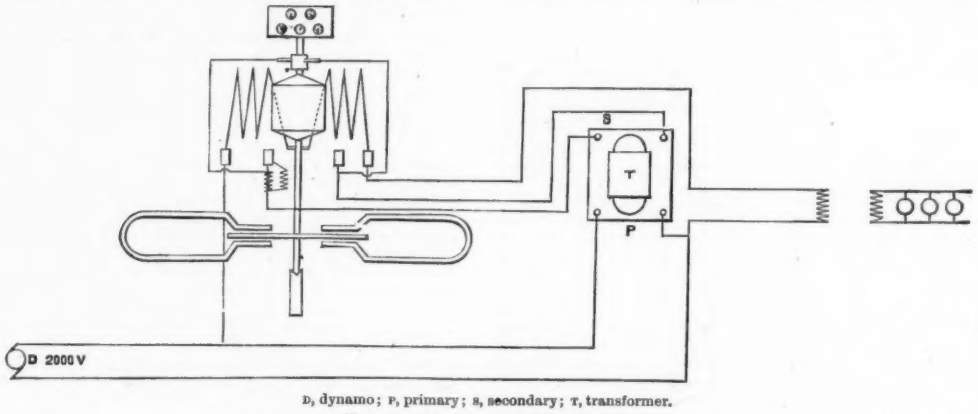


Three-wire.



Five-wire.

Thomson-Houston primary meter. This instrument is one with which most of you are already familiar, and consists of an ordinary Thomson-Houston meter, such as has already been described, having the series coils specially insulated to allow of its being used on a



D, dynamo; P, primary; S, secondary; T, transformer.

Primary of Alternating System.

high tension circuit. The volts for the shunt coil are reduced from 10,000 or 2,000, whatever they may be, to 50, by means of a transformer, and this combination, although claimed by several people, was originally suggested and used by Prof. Elihu Thomson to measure the true watts coming out of alternating current stations as long ago as 1888 experimentally, and was put on the market commercially in 1889. The use of the transformer does not interfere with its accurate registration for the reason that the current absorbed by the shunt coil is so small in proportion to the output of the transformer that the lag in its secondary current is 180° behind the primary E.M.F., or, in other words, to all intents and purposes coincident with it, so that at any given moment $c \times e$ gives true watts, as the registrations are not those of the mean current multiplied by the mean E.M.F. The importance of this is so self-evident in a high tension station, either with the transformers banked, or in customer's premises, that it requires no comment, and it is interesting to be able to state from the actual experience of a large number of central station engineers who are using these meters to ascertain practically the ratio between the apparent and true watts sent out of the station, that Dr. Fleming's anticipations are very nearly realised. In a paper read before the Society of Electrical Engineers in London, he stated that the apparent would be about 14 per cent. higher than the true watts; as a matter of fact, in practice, this figure varies, but it is generally in the region of 12 per cent.

The meter itself consists of U-shaped tube filled with a suitable liquid, having a bulb at each end, one of which is surrounded by a coil in series with the ordinary meter, the other being bent down to form a trap. The current passing through the series coil heats and therefore expands the air contained in the bulb it surrounds, and forces the liquid into the bulb at the other end; the quantity of liquid thus caused to overflow diminishes the height of the liquid standing in the right-hand tube, and thus gives a registration of the maximum demand this particular customer has made on the plant at the station, during the quarter.

The following are examples of scales showing different methods of benefiting long-hour consumers, and thus encouraging profitable business. The first is the Brighton scale, and its great simplicity will at once be apparent. Current is supplied at 115 volts.

Maximum demand. Ampères.	Instrument tube holding registering fluid.	Number of units to be consumed in half-year at 7d. All surplus at 3½d.
1	—	= 42 units.
2	—	= 84 units.
3	—	= 126 units.
4	—	= 168 units.
5	—	= 210 units.
6	—	= 252 units.
7	—	= 294 units.
8	—	= 336 units.
9	—	= 378 units.
10	—	= 420 units.

Example:—A customer's consumption in the half-year amounts to, say, 564 units, his indicated demand being 8 ampères. He will then pay as follows:—

	£	s.	d.
336 units at 7d. =	9	16	0
228 units at 3½d. —	3	6	0
564	£13	2	6

The next is a scale that has been tabulated for a company that has hitherto given discount, proportional to the amount of the account, regardless of the actual maximum number of lamps in use at any time.

Should the customer's consumption at the indicated demand not reach the figures in the first column, he is charged full price. Should the consumption exceed the figures in the first column, but not exceed those of the second column, he is to receive 5 per cent. discount off his account. Should this consumption range between the second and third columns, he receives 10 per cent. discount, if between the third and fourth, 15 per cent., and so on.

The basis of the different discounts is as follows:—

5 per cent. when consumption equals customer's maximum demand for 700 hours in the year.

10	»	»	»	1,000	» »
15	»	»	»	1,200	» »
20	»	»	»	1,500	» »
25	»	»	»	1,800	» »

Voltage 110.

Maximum demand. Ampères.	Instrument tube holding registering fluid.	Discounts. 5 p.c.	10 p.c.	15 p.c.	20 p.c.	25 p.c.
		When following minimum quantities are consumed.				
1	—	77	110	132	165	198
2	—	154	220	264	330	396
3	—	231	330	396	495	594
4	—	308	440	528	660	792
5	—	385	550	660	825	990

Example:—If a customer consumes in the whole year 960 units at a maximum demand of 5 ampères, he is entitled to a discount of 20 per cent., which, at 8d. per unit, works out as follows:—

960 units at 8d.	£32	0	0
20 per cent. discount ...	6	8	0
	£25	12	0

The discount for the year is, in this case, deducted from the customer's bill at Christmas, that being the darkest quarter, and also ending the financial year.

The scale of discounts last given may be modified so as to offer a rapidly rising bounty, to long hour consumers especially, but considerations of space will not now admit a fuller reference to this arrangement. The same reasons have curtailed the scales here described, but obviously they may be extended as desired.

One thing of exceeding importance has been demonstrated, viz., that reductions in price on the basis of the foregoing scales will induce customers to wire their buildings more thoroughly, thus giving the works a long and profitable load, while the consumer obtains current at a sufficiently moderate price to efficiently compete with gas.

Where motors are used the instrument is equally useful, as the customer reaps the benefit of a long hour load by getting a liberal discount off his whole bill.

There are, of course, very many other features in the meters referred to in this paper that deserve notice; but the limited time available has of necessity rendered this paper very incomplete. The author hopes, however, that it possesses some points of interest to members of this Society.

Discussion.

A short discussion followed the reading of the paper.

Mr. Wordingham said a maximum demand meter, such as that of Mr. Wright's, mentioned in the paper, was wanted. The Thomson meter had been used for the five-wire system in Manchester, and for the three months it had been working, it had proved very satisfactory.

Mr. Bennett said he had several objections against the Aaron meter, one of these was its troublesome clockwork and frail case, which made it not very durable in a damp place. Then there was a great deal of trouble in synchronising, four weeks or more being necessary to get it properly adjusted.

Mr. Madgen said electrical engineers had devoted great energy during the last dozen years in endeavouring to get extra efficiency out of their transformers, dynamos, &c., but they had not shown the same energy with regard to the meter. A very pertinent question was with regard to the amount of current taken by the shunt in the Thomson meter. In meters tested by supply-station managers of his acquaintance, the resistance of the shunt was 1,000 ohms. He was glad Mr. Wilson had commended the maximum demand meter introduced by Mr. Wright, of Brighton, and he had received very satisfactory reports as to its efficiency.

Mr. Wilson in replying upon the discussion, said the drop in Wright's meter was very small, and the drop in the series coil in Aaron's meter was not very appreciable. By far the largest number of meters in use at the present time were of the Aaron type, and he thought the difficulty of adjusting in this class of meters had been largely exaggerated by Mr. Bennett. With due care a very good watchmaker could undoubtedly adjust them, so that they would work satisfactorily.

The proceedings then closed with the usual vote of thanks.

NEW PATENTS—1894.

6,512. "Improvements in dynamo-electric generators and motors, and allied machines." F. H. Royce. Dated April 2nd.

6,528. "Improvements in dynamo-electric generators and motors and allied machines." F. H. Royce. Dated April 2nd.

6,554. "Improvements in or additions to metallic tubular telegraph poles and metallic tubular poles for other purposes." Bullers, Limited, and E. J. Chambers. Dated April 2nd.

6,589. "Improvements in or relating to indicators or telegraphs for cabs or other vehicles." R. Bowes. Dated April 2nd.

6,606. "Systems for controlling electric lights." C. A. Allison. (Communicated by The Electrical Specialty Company, United States.) Dated April 3rd. (*Complete.*)

6,623. "Improvements in electric lighting apparatus." P. R. Allen. Dated April 3rd.

6,649. "A new or improved mechanical indicator for electric and other bells." A. Kershaw. Dated April 3rd.

6,661. "Improvements in electric switches." T. J. Rorke. Dated April 3rd.

6,669. "Improvements in porcelain and other insulators." J. C. Fuller, G. Fuller, and W. E. Langdon. Dated April 3rd. (*Complete.*)

6,721. "Improvements in apparatus for signalling between police stations and district call-boxes." The National Telephone Company, Limited, and C. Eggar. Dated April 4th.

6,732. "Improvements in apparatus or machinery for making draught extinguisher strips for covering electric cable wires with ribbon and for like uses." G. Clapham. Dated April 4th.

6,742. "An electrically-operated electric switch." Siemens Brothers & Co., Limited, and G. S. Grimston. Dated April 4th. (*Complete.*)

6,755. "Improvements in gas engines." P. A. Low. Dated April 4th.

6,822. "Improvements in turbines driven by steam or gas." L. Bollmann. Dated April 5th.

6,850. "Electric-lamp protector." W. T. Ungley, Jun. Dated April 6th.

6,863. "Improvements in steam turbines." N. G. K. Husberg. Dated April 6th.

6,888. "Improvements in telegraphic and telephonic apparatus." J. Imray. (Communicated by La Société Anonyme pour la transmission de la force par L'electricité, France.) Dated April 6th.

6,912. "Improvements in and relating to moulds for casting grids for the active material of electrical accumulators." The Firm of Kolner Accumulatoren-Werke Gottfried Hagen and C. Beyer. Dated April 6th.

6,917. "Improvements in apparatus for electrolytical purposes." H. Guthrie. Dated April 6th.

6,937. "An improved method of illuminating by the electric arc." W. Dixon. Dated April 7th.

6,942. "Improvements in "cords" and plugs for telephonic switchboard circuits." D. Sinclair. Dated April 7th.

6,947. "Improvements in plates or electrodes for accumulators." R. J. Gulcher. Dated April 7th. (*Complete.*)

6,975 "Improvements relating to the manufacture of plates or electrodes for electric accumulators or secondary batteries, and to machinery or apparatus therefor." A. J. Smith and H. J. Wright. Dated April 7th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

222. "Improvements connected with electric belts and bands for curative purposes." N. Mitchell. Dated January 4th. Claims:—1. Combining medico-electric chain or band elements in the body of a belt, by spun or curled conducting wires in the elastic parts thereof, substantially in the manner shown on the drawings, and as described for the purposes set forth. 2. The employment of helically spun, or other like wires, in or on the elastic portions of a body belt as means for connecting electric elements affixed in or to the leather or canvas portions of such a belt, as set forth.

1,354. "Electro-thermal conductors, plates, tubes, and the like." Sir C. S. Forbes. Dated January 21st. Consists in the use and employment of absorbent minerals of a refractory nature capable of resisting heat. 4 claims.

1,812. "Electric light regulating switches." R. J. Sansome and H. Hawes. Dated January 27th. Relates to a resistance switch to regulate the light of incandescent electric lamps, from its greatest brilliancy till it reaches redness, and to switch off altogether. 3 claims.

1,894. "Improvements in self-regulating dynamo-electric generators and motors." I. A. Timmis and A. I. Smith. Dated January 28th. Claim:—In dynamo-electric generators and motors working at varying speeds, the method of regulating the same with the object of providing a constant output by means of reverse currents circulating in separate coils on the field magnets, substantially as described and shown.

1,902. "Improvements in or relating to metallic junction boxes for concentric electric conductors and in the mode of connecting conductors therein." H. A. Mavor, W. A. Coulson S. Mavor, and W. B. Sayers. Dated January 28th. The outer metallic sheathing and lead covering, either one or both, according to the type of cable or conductor upon which the connection is to be made, and the succeeding layers of which the cable is composed are cut away in steps at the point where connection has to be made, leaving suitable lengths of the layers of insulating and conducting material projecting. A contact button is then soldered upon the central conductor; next a metallic cup or thimble, having a central hole co-axial with the rim of such diameter as to pass small end of a connecting plug, and one or more notches or side openings, according to the number of conductors passing into or out of the box, of suitable shape and of depth to allow the insulated central core of the conductor to pass into the interior of said cup, is placed upon the cable so that the contact button is opposite the co-axial hole in the cup or thimble. 2 claims.

2,159. "Improvements in or connected with electric arc lamps." J. H. Rose. Dated January 31st. Relates:—1. To an arrangement for temporarily stopping the feed of the carbon pencil when its holder is raised for striking the arc. 2. To means for adjusting the relative positions of the electro-magnet and armature of the shunt circuit. 3. To means for permitting the vertical adjustment of the lower carbon with respect to the upper carbon. 4. To the construction of the frame or casing enclosing the clockwork mechanism. 4 claims.

2,167. "An improved apparatus for registering telephone calls." L. Kahn. Dated January 31st. This apparatus enables the change of direction of the electric current by which telephone calls are registered to be produced by means of a switch lever adapted to be set to the characters or signs to be given at the call station. 1 claim.

3,274. "Improvements in electrical transformers, and in boxes or casings therefor." W. C. Johnson and S. E. Phillips. Dated February 14th. Claims:—1. For an alternating current transformer with closed magnetic circuit, a core of rectangular shape, consisting of thin iron plates alternately long and short, so that the plates interlace at each angle where they are clamped by insulated bolts, substantially as described. 2. In a transformer such as is above-referred to winding the primary and secondary coils separately on sleeves of insulating material, slipping the larger sleeve over the coil on the smaller, and slipping the whole over one or each of the long limbs of the coil, substantially as described. 3. For holding a transformer such as is above referred to, a box and cover having ribs between which the short limbs of the core are steadied, and having vertical channels for circulation of insulating liquid, with which the box is charged, substantially as and for the purpose set forth. 4. A transformer and box, substantially as described with reference to the drawings.

4,976. "Improved apparatus for working railway switches by means of electrical energy." Siemens Bros. & Co., Limited. (Communicated from abroad by Messrs. Siemens and Halske, of Berlin.) Dated March 7th. Relates to apparatus for working switches on railways wherein the setting and locking of the switches is effected by means of an electro-motor, and in which a control apparatus is made to indicate to the pointsman the proper closing of the points, as also the forcing open of the points by a train and any irregular working of the apparatus such as interruption of the electric circuit. 3 claims.

10,095. "Improvements in electroplating." E. de Pass. (Communicated from abroad by H. Thofehrn, of Paris.) Dated May 20th. In order to obtain a smooth deposit of copper, or other metal, upon a cylinder, or a moulded or shaped article, rotating in an electrolytic bath, or upon an article placed in the bath, such as a plate, the surfaces to be plated are showered with a stream or jets, under pressure, of the electrolyte. 4 claims.

16,389. "Improvements in electric heating apparatus." J. F. McElroy. Dated August 31st. The object of the invention is to provide an electric heater particularly adapted for use in offices or other apartments in which the resistance is placed within a casing similar in design to a stove. 4 claims.

18,386. "Improvements in electrical switches." E. W. Lancaster. Dated October 2nd. Claim:—The combination of an insulating base and metal pieces for making or breaking an electric circuit at four points, as described and illustrated.

19,423. "Improved continuous electric current distributing system." M. Von Dolivo-Dobrowolsky, and the company Allgemeine Elektricitats-Gesellschaft. Dated October 16th. Relates to the distribution of continuous electric current, and more especially to the feeding with such current of two series connected consumption circuits by the aid of the so-called three-wire system, and its object is to enable this system to be worked by the medium of but one current generating machine without sparking being caused at the point of connection between the neutral or compensating wire and the dynamo machine. The arrangement consists in dividing the exceeding current flowing back through the compensating wire into two partial currents, and causing the latter to directly flow at diametrical opposite points into the armature winding of a dynamo connected with the mains, the said dynamo consisting either in the generating dynamo itself or in a compensating machine, viz., a dynamo, receiving current from the mains and running as an electro-motor. 3 claims.

19,529. "Improvements in automatic central telephone switch apparatus." F. Nissl. Dated October 17th. Relates to apparatus whereby a single main circuit can be employed for connecting several speaking stations situated at comparatively short distances from each other to a central station, so as to obviate the considerable costs and inconveniences arising from the use of a separate circuit for each speaking station. 8 claims.

19,534. "Improvements in and relating to electric light switches and wall plugs." G. Davis. Dated October 17th. Relates chiefly to improvements in electric light switches and wall plugs, in which the connecting or contact medium is quicksilver. 3 claims.

19,542. "Improvements in apparatus for the electrolytical decomposition of salt solutions." C. Kellner. Dated October 17th. Comprises a number of conducting plates held at a suitable distance apart by insulating rods, the whole forming a "bleaching block." 2 claims.

19,789. "Improvements in electric railways." Sydney Pitt. (A communication from abroad by the Universal Electric Company of New York.) Dated October 20th. The object of the invention is to provide a system that may be economically installed and operated, and in which loss of current due to leakage, as well as the element of danger where high tension currents are employed, may be practically eliminated. 17 claims.

20,069. "Improvements in apparatus for controlling the application or use of electric currents of high tension and great quantity." R. Lundell and E. H. Johnson. Dated October 24th. Has for its object—1. To construct a switching device or apparatus which shall first rupture the circuit at one or more points, and then effect certain changes in the circuits of an electric motor, after which the circuit is again restored at the point or points of rupture. 2. To avoid, as far as possible, injury from abnormal arcing at the points of rupture of the circuit or circuits which supply the operating current. 3. To construct a current controlling apparatus which shall permit various changes to be effected in the motor or translating device with the simplest possible arrangement of parts, and with a view of securing certainty of action without damage to any part of the apparatus. 9 claims.

20,458. "An electric switch." E. C. de Segundo. Dated October 30th. Claim:—An electric switch wherein a bent spring connected to the one wire is caused by the turning of a knob and sunk ring in the one direction, to ride over and snap behind a latch connected to the other wire, and by the turning of the knob and ring in the opposite direction, the spring is raised by an incline of the ring so as to become disengaged from the latch, substantially as described.

20,735. "Improvements in lightning conductors." J. Ball. Dated November 2nd. Has for its object the construction of a continuous lightning conductor, *i.e.*, a lightning conductor which has no couplings or connections, whereby its efficiency is greatly increased. 2 claims.